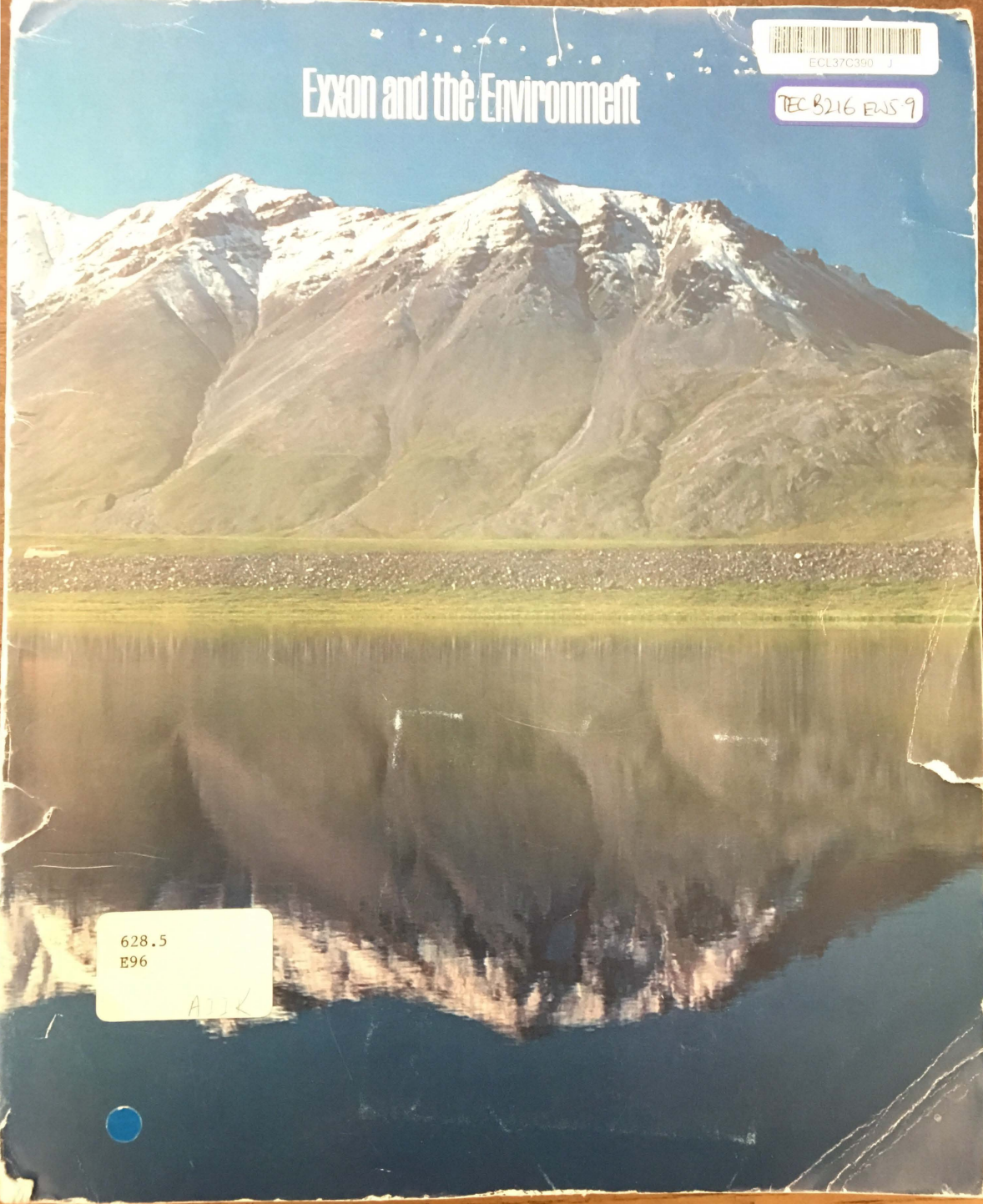
Exxon and the Environment



Exxon and the Environment

EXXON

C.C.GARVIN, JR.
Chairman of the Board

December 19, 1975

ENVIRONMENTAL CONSERVATION
IS AN EXXON COMMITMENT

In recent years, publications of Exxon and its affiliates have reported on the corporation's continuing efforts to protect the environment. While considerable progress has been made in the area of environmental conservation, the task is by no means finished. This anthology of articles published by Exxon thus represents some snapshots of what is an ongoing effort.

The anthology begins, appropriately, with a comprehensive statement by J. K. Jamieson, former chairman of Exxon, that appeared in The Lamp magazine in November 1974. The statement still reflects Exxon's views and position on this most important subject.

We have chosen to close the anthology with another statement by Mr. Jamieson, published in 1972, that also remains timely. Mr. Jamieson referred to the "energy-environment equation." He expressed confidence that "practical and effective answers can be found to the equation--that the conflict between the need for more energy and the desire to preserve the quality of life will be resolved. But our success will depend upon the amount of patience, determination, intelligence, and hard work that we are willing to bring to the task."

As we move ahead with the urgent business of meeting future energy requirements, so, too, must we fulfill our obligation to protect the natural environment. While they may be difficult to achieve, I believe the two goals are compatible.

C C Garvin Jr.

Exxon and the Environment

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Introduction

The articles in this publication have appeared in magazines published by Exxon Corporation and its affiliates over the last several years. They show the extent to which environmental protection has become an integral factor in Exxon's operations and planning. Covering a time span, the articles also indicate how the concepts of environmental conservation have been steadily changing. Some projects, described at their inception, have since come to fruition; the full effects of some will not be evident until they are widely applied; and others are still in the development stage. But significant progress has been achieved in cleaning up and protecting the environment through widespread industrial and governmental efforts. A cleaner environment, with benefits to all of us, is a reasonable expectation for the future.

Exxon's commitment to conservation is embodied in four objectives adopted by management. They are:

> To make sure that the corporation's operations and products do not create hazards to public health and are compatible with community needs and environmental, social and economic aspirations.

> To work with outside groups for a consensus on desirable and attainable standards.

> To work with government to foster timely development of regulations affecting operations and product quality needed to achieve such standards.

> To adhere to all environmental standards and regulations which may be applicable to Exxon's business.

We issue this publication in the conviction that a well-informed public will appreciate the nature and complexity of the problems associated with environmental conservation and has a vital role to play in making the value judgments that will serve the good of society in the long run.

Exxon and the Environment

About two and a half years ago, in these columns, I spoke of the "energy-environment equation." One part of that equation involves supplying the vast amounts of energy required by an expanding world population. The other part consists of the necessity of protecting the natural environment upon which the quality—and very survival—of life on this planet depends.

Recently, the energy part of the equation has attracted by far the greater public attention, and understandably so. The crude oil embargoes, shortages of petroleum products, increasing oil prices, a worsening natural gas shortage—these and other developments have dominated the news and evoked widespread concern. We do, indeed, face a serious energy problem in the United States and throughout the world. But we should not lose sight of the other part of the equation—the continuing need for conservation of our natural environment.

There is clear evidence that the public has not lost sight of that imperative. A recent public opinion survey conducted for the United States Environmental Protection Agency showed that most Americans are as much or even more in favor of fighting pollution than they were a year ago, regardless of how they have so far been affected by any fuel shortage. There is general agreement, too, that reducing fuel consumption and increasing supplies are much better means of tackling the energy problem than relaxing existing environmental quality standards.

Of course, Exxon continues to urge a reasonable balance between the goal of improving environment and other national objectives, including adequate energy supply. We have recommended that costs—in terms of both money and resources employed—be carefully weighed when establishing environmental improvement goals.

Like that of the public, Exxon Corporation's commitment to environmental conservation is strong—as it has been for many years. Evidence of our commitment is the fact that our spending for environmental purposes has been steadily increasing year by year. In 1974 Exxon is expending about $575 million compared to $350 million in 1973, and we foresee another sizable increase in 1975. Over the nine-year period of 1966-1974 our spending for environmental protection programs will total more than $2 billion.

A further indication of our commitment is manpower. Exxon now has about 300 employees working full-time, and more than 1,000 part-time, directly on environmental matters.

Why have we made this large investment in money and manpower?

A principal reason, of course, pertains to the requirements of legislation, the goals of which we endorse. We recognize that the natural environment has been damaged by the operations of our own industry, along with many other activities that are a part of an urban and industrialized society. We realize that cleaner operations are healthier and safer, for the public and for our employees. To these ends, we support efforts to prevent and repair environmental damage. It is, after all, a matter of self-interest. No company can ignore its social responsibilities if it wishes to endure as a viable enterprise.

The financial extent of Exxon's commitment to environmental conservation is on record. But just what have we gotten for that $2 billion in anti-pollution expenditures?

We have had some striking results.

There is, for instance, the troublesome problem of contaminants in the water discharged from refineries. The oil content of the water effluent from Exxon's refineries around the world—never a large amount—has in the last four years been reduced by almost two-thirds. In the same period the amount of crude oil we processed grew by one-fifth. The reduction was achieved by a multifaceted effort, involving employee awareness, training, and spending on improved facilities and special equipment. We anticipate still further reductions over the next few years.

We found that it is possible to achieve some striking results in pollution control without necessarily spending a great deal of money. At our chemical plant in Rotterdam, for example, the amount of oil effluent discharged to sewers was reduced by 95 percent over a two-year period. This was accomplished through an intensive employee awareness program, combined with relatively small expenditures on new facilities. This effort paid for itself in six months through savings in pollution taxes levied on the plant.

It would be impossible to overemphasize the importance of the human element—alert and well-trained employees—in any successful corporate environmental-protection effort. I'm sure this has been a major factor in improving our tankers' oil spill frequency record. A recent analysis of our records and U.S. Coast Guard data showed that on the heavily-traveled East Coast of the United States, the performance of tankers in Exxon service was particularly good. This can be attributed to the special training of personnel on Exxon-owned tankers and to careful selection of chartered vessels. Keep in mind, any discernible amount of oil in the water is considered a "spill incident." About 70 percent of all such spills involved less than five barrels.

Other significant results of our anti-pollution spending include:

Cleaner products. At refineries in the Caribbean, for example, we have installed facilities to reduce sharply the sulfur content in heavy fuel oil be-

Statement by Exxon's Chairman, The Lamp, *Winter 1974.*

Efforts to protect the environment must continue while world energy problems are solved. Exxon's chairman presents a progress report and a pledge for the future.

fore it is shipped to markets along the East Coast of the United States. The result has been a significant reduction in sulfur oxide emissions and cleaner air for cities that use this fuel to generate electricity, run factories and heat apartment houses, hospitals, schools and other large buildings.

Most of our service stations across the nation and in Canada are now marketing unleaded gasoline, required by the exhaust-emission controls on the latest-model cars.

> Sounder planning. We have analyzed the environmental impact of our major operations, and we have continued to revise and update operating manuals outlining the best control procedures to be used. The potential environmental impact of any new activity is now assessed as a normal part of our business. We cannot take the traditional view that use of the environment is "free."

> New anti-pollution devices. Exxon Company, U.S.A., our domestic affiliate, has developed an improved boom to contain oil spills in rough seas. Our United Kingdom affiliate has devised a versatile skimmer to pick up spilled oil.

Not all conservation devices are complex. Exxon USA equipped its inland barges with a six-inch-high guardrail to contain small deck oil spills.

> Protection against property loss. Exxon has participated in the formation of two worldwide industry organizations which expedite cleanup of tanker spills. Together they provide up to $30 million for each incident to reimburse governments or others for the cost of cleanup and for losses caused by oil spills. Meanwhile, our Canadian affiliate has been a leader in organizing industry cooperatives to contain and remedy oil spill accidents.

> Better mining practices. As newcomers to mining, we are able to avoid many of the pitfalls of earlier mining practices. We feel that Exxon's coal and uranium mining operations are carried on with great care for the protection of the environment. Reclamation of disturbed areas is an integral part of all our mining plans.

Research—a never-ending process—is another vital part of our environmental conservation effort. In fact, almost all of the products and processes mentioned above had their origin in the laboratory.

For example, the desulfurization process used at our Caribbean refineries is one of the three such processes developed by our researchers. Other Exxon research projects are seeking ways to turn coal into cleaner burning liquid and gaseous fuels. Still other technologies are being developed to reduce sulfur oxide emissions from combustion of fuels before they go up the stack. And to combat oil spills, Exxon Research and Engineering Company introduced a number of low-toxicity dispersants that have been used successfully in many parts of the world.

Some of the most valuable benefits of our conservation efforts are intangible. We have learned a great deal about how our operations can affect the environment, ranging from the effects of oil spills on the marine environment to the possible effects of oil company operations on permafrost in the Arctic regions.

As a result, we have broadened and strengthened our ability to respond to environmental problems. With our new experience and technology, we can plan more quickly and easily to minimize long-range problems and can respond more rapidly to pollution emergencies.

Aside from Exxon's and the petroleum industry's anti-pollution efforts, what has been accomplished more broadly to improve or protect the environment on the national and international level?

Genuine progress has been made by citizen efforts, private industry and public agencies, even though environmental successes have not been as widely reported as the failures. Fish are reappearing in what were some of the world's most heavily polluted rivers. The air of many major cities is measurably cleaner than it used to be. As the full impact of programs now in effect is felt, further successes will be seen.

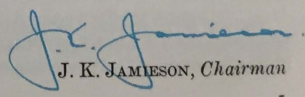
But the hard fact is that despite demonstrable progress in many aspects of environmental protection and conservation, some tough problems have yet to be solved. In the conventional oil and gas business, we will continue our efforts to reduce oil spills, odor and noise.

And looking somewhat farther ahead, supplemental energy from coal, shale oil, tar sands, very heavy oil, as well as from geothermal and nuclear sources, is likely to become increasingly important. Each of these will present its own particular set of environmental problems, including such serious ones as water availability, waste disposal and land reclamation.

We have made good progress in environmental conservation, but the effort must be continued. Under present circumstances it is essential that measures to improve the environment be balanced with the pressing need to maintain and expand energy supplies.

Exxon Corporation will stay the route. We expect to play a continuing role in solving the world's energy problems, and we reaffirm our long-standing commitment to protect the earth's air, water and land resources.

November 7, 1974



J. K. JAMIESON, *Chairman*

the oil industry and the environment

The energy supplying industry, and petroleum is certainly a major component of it, has a dual obligation to the public. That is, it must continue to meet the seemingly limitless energy needs of its customers from oil resources, on which nature has already imposed some severe restraints. More and more, man is imposing his own restraints on these supplies in the form of environmental regulations, which the industry also must respect. At times, this dual obligation can create a conflict. We are now seeing this vividly in the U.S. where prevailing environmental restrictions on the construction of new installations and on product quality are hampering our oil production and supply efforts. The delay in the building of the pipeline from Alaska's North Slope is one major example. To a significant extent, such developments are contributing to the energy "crisis" which is probably one of the most urgent problems which the U.S. Government, industry and the general public must deal with today. Just this past winter in the U.S., some local regulations concerning fuel quality had to be relaxed in order to maintain the flow of energy. It must be evident that the rest of the world is not immune to this same problem. And one major conclusion is that we must balance, and continually reweigh, our environmental aspirations and our real need for energy.

We did not wholly anticipate this conflict with energy supply as we watched the environmental movement grow since its inception in the early 1960s. In the U.S., we saw the movement percolate to the surface of public opinion, and then spread rather rapidly into a general awakening that grew into a furore of public feeling. Pollution became headline copy; demonstrators marched with stark demands on their placards; and alarming speeches often exaggerated or distorted the nature of the environmental challenge.

Today, the U.S. temper is somewhat different. Public intensity seems to have reached a plateau. However, a very high plateau, I might add. At the same time, in tackling our pollution problems we've found them to be more complex and interrelated than we first believed. As this realization has filtered through to the general public, along with such important issues as the energy supply and the economics of pollution control, idealistic demands seem to be giving way to realism.

The situation here in Britain and Europe appears to be somewhat different. My own assessment is that public concern here is still rising. However, I believe that it should eventually reach a plateau but at a lower level of intensity than we experienced in the U.S. One reason that occurs to me is a very elementary one—the fact that the problem itself has not struck Europeans as a novel dilemma. In the States, the realization that pollution could damage, and was damaging, the land's ecology clashed with Americans' characteristic and persistent concept of their country as an unspoiled land of limitless dimensions and resources.

On the other hand, your greater population density and much longer history seem to have made Europeans inherently more aware of the vital need for environmental conservation. Consequently, when concern did begin to build up, it came as no great surprise here or on the Continent. Response was less emotional, and, fortunately, pragmatic assessments of the problem were in some cases made fairly early in the game. As we have heard from our previous speakers, those efforts are continuing.

However, I believe it is still not fully realized here or in the States that environmental conservation is a *global* challenge, created by many sources, all of which are *not* man-made. There are many cures and many responsibilities. Industry has some of them, but we must bear in mind that even if industry were to be without fault, the improvement in the overall environment would be small compared to the improvement required to meet public expectations. Indeed, it might hardly be noticed. To borrow an example I recently heard, we can say that all ducks are birds, but the reverse is not true. In like manner, while all industrial pollution *is* pollution, all pollution *is not* industrial pollution. Therefore, while a healthier environment is undoubtedly the goal of all parties, that goal cannot be narrowly construed as the job of industry, still less the job of any one industry such as ours.

I do not say this by way of excusing the petroleum industry. International oil companies play a definite role in the global environmental effort wherever in the world they have operations. From the first seismic shot in our oil exploration activity on through our producing, refining, transportation and marketing operations—every step of the way—the oil industry comes in contact with the environment. The environment is not a new concern for the industry. However, in the last several years, it has undoubtedly gained a much higher priority. Accordingly, the pace and number of industry actions have been stepped up. In order to define and make commitments for my company, for example, we have established some specific corporate environmental objectives. These are based on the desire of our top management to do whatever is reasonable and feasible, with the constraints of technology and economics, to make our products and worldwide operations environmentally sound.

In our New York headquarters, my staff and I work with our affiliates in all parts of the world in which our company operates. While all of our employees play a role in our environmental programme, within our worldwide organization there are more than 500 people whose principal concern is to deal with the company's environmental problems. We look to all our

Remarks by Dr Raymond W. Winkler, Exxon Corporation's Environmental Conservation Coordinator, European Review, *Summer 1973.*

employees to implement our corporate policy and to ensure that we achieve our objectives in all our operations. Thus, we and many other companies have the necessary organization and we are working hard to supply solutions for the detrimental effects our activities can create in the environment.

Since every phase of the petroleum industry touches the environment, it is quite natural that our environmental problems are plentiful. We can look at them in a number of ways. For example, some result from our regular operating activities. Among many others, these problems include controlling discharges of harmful materials in the air and water effluents from our refineries; minimizing the release of oil from tankers and other vessels; minimizing the risk of environmental damage from our extensive pipeline network; controlling the release of offensive odours, and minimizing the noise from our operations, particularly those located near residential areas.

Exxon Research and Engineering's automotive emissions control laboratory at Linden, New Jersey.

Beyond its own operations, the industry also must supply products that efficiently meet the environmental needs of its customers and those of the communities in which these products are used. As one example of the product quality improvement required by local regulations, the production of low-sulphur fuel oil in Japan and in the Caribbean area has required very substantial investments in refining facilities. Future European fuel quality is now being considered by the OECD and the Common Market. I would hope the experiences in Japan and the Caribbean would emphasize to these two organizations the tremendous amount of capital which would be required, as well as the cost the consuming public would have to pay, for control measures. Obviously, these efforts should be considered before legislating, so that benefits are commensurate with the added costs.

Similarly, you are aware of the interest exhibited by some governments to reduce the amount of lead in gasoline. It certainly would be necessary to reduce or remove lead from gasoline if catalytic devices which are intolerant of lead are installed to control automotive emissions. However, some reductions of lead have already been made even though the available medical evidence is not convincing that lead from auto emissions is detrimental to public health. Further reductions will be costly and they will require substantial capital investment. Unless lead removal shows some tangible beneficial effect, then, this use of capital, which might better be applied elsewhere, would seem to be the antithesis of conservation.

I might add, however, that in many cases the industry can do little to control some of the environmental problems related to the use of its products. For example, a poorly maintained automotive engine or an inefficient oil burner can produce a considerable amount of undesirable emissions, regardless of the quality of the product being burned.

The oil industry also must be and is concerned about environmental problems resulting from accidental discharges. Here I refer to the highly publicized oil spills from such mishaps as tanker accidents and offshore well blow-outs. While these incidents attract much attention, they have probably caused less environmental damage than have our operational discharges. Nevertheless, the industry has devoted considerable effort to minimizing these accidental occurrences. We have provided facilities for tanker captains to practise their manoeuvring and berthing skills in scale model tankers operating on an 8-acre lake in Grenoble. At another school, the Institute of Applied Scientific Research, at Delft in Holland, a captain can practise his navigational skills on a tanker simulator. This functioning mock-up of a ship's bridge is designed to provide realistic simulation of tanker operations in all the major harbours and passages of the world. In my company we have established an oil well blow-out prevention school. Men who are involved in drilling for our oil are trained specifically in the techniques of preventing runaway wells and in the early detection and handling of potential well blow-out situations. We also have "port inspectors" at most of our major European discharge terminals. These men, who are retired tanker captains, are employed to advise ship and shore personnel how to unload tankers without fouling harbour waters.

Nevertheless, since virtually all of our operations have a human element in their

performance we will never be totally free from the chance of accident. Therefore, we must be prepared to deal with these mishaps on those rare occasions when they occur, and this has been done in many places throughout the world. We've learned a lot since the *Torrey Canyon* disaster in 1967. And now, with oil spill clean-up equipment stocked at strategic locations, with emergency operating plans, and with organizations established in key centres throughout the world, we certainly are prepared to handle these emergencies much more efficiently.

In cases where a spill does occur, we can call into action two agreements which the oil industry and the tanker owners formed on their own initiative several years ago. These agreements, known by their acronyms TOVALOP* and CRISTAL,** provide funds to clean up spills and to compensate for damage. The important point here is that prompt clean-up action can be started without waiting to determine liability and that adequate funds are available for clean-up and to compensate victims.

While TOVALOP and CRISTAL are relatively new developments, another environmental effort by the industry dates back to 1963. In that year, industry members formed an organization called the Oil Companies International Study Group for Conservation of Clean Air and Water in Western Europe. Understandably, the group is better known by its nickname—CONCAWE. CONCAWE's work covers air, water and noise pollution, the disposal of solid wastes related to the operation of oil refineries, the storage and use of oil and its transportation by all means except tanker. Since problems in these areas affect all oil companies, CONCAWE, through its joint environmental study and wide representation, can discuss conservation with national and international bodies as the spokesman for all oil companies that have refinery operations in Western Europe. CONCAWE's goal is to coordinate and intensify the efforts of these oil-refining companies to achieve rational solutions to the environmental problems they face.

What the oil industry is doing can be seen in terms of the money being spent as well as the problems being attacked. I am acutely aware of the hazards and deceptions that accompany the use of statistics and expenditure figures. However, I would like to cite a couple of figures to give you some idea of the magnitude of our environmental effort. I would estimate that in general the international oil industry is now devoting almost 10 percent of its annual capital expenditures to environmental conservation. I know this is the case in my company. In 1966, the first year for which we collected the data, 3 percent of our capital expenditures were for environmental purposes. By 1972, the figure had climbed to 9 percent and we expect it to continue rising. In 1972, our worldwide expenditures for environmental conservation totalled almost $300 million. Since 1966, the corporation has spent a total of $1.2 billion for this purpose. While almost two-thirds of that total was for our U.S. market, spending outside of the States is growing steadily and substantially.

In recent years, the oil industry's environmental improvement efforts have resulted in many specific changes in equipment and procedures. Some long-standing concepts in the industry also have become antiquated. For example, new refineries are no longer planned so that they use enormous quantities of cooling water on a once-through basis. Instead, air cooling or recirculated water is used. At old refineries, changes are being made both to reduce the volume of water used and to clean the water more thoroughly before discharging it.

We are going to considerable effort to make each of our employees extremely sensitive and aware of the environmental impact of his individual actions—or of his inaction. We have found many instances where our training programmes have resulted in substantial reductions in undesirable discharges from our plant operations. And the employees involved have developed a sense that they are improving the quality of *their* environment.

As you might expect, the research effort is of key importance to finding solutions for environmental problems the petroleum industry encounters. For example, not only must we prevent oil from getting into the seas, we must also learn more about what happens to it when it does. In like manner, we must seek alternatives in the control of air pollution by such means as removing sulphur from the stack gases rather than from the fuel itself. There are many others. These research projects are vital because in all too many cases we are already working at the limit of our technology and must depend upon some technical breakthrough if we are to make further improvements. Thus, my company is spending more than $17 million on research projects designed to help conserve the environment. We do not expect that this task of data-gathering and technical improvement will ever really be finished. It is growing each year and will, I'm sure, continue to expand.

One of the factors contributing to the requirement for more research is the oil industry's need to explore for and produce petroleum in such hostile places as the North Slope of Alaska, the Bass Strait off Australia, and the North Sea. Since these locations present more hazards, many additional precautions are necessary to protect the air, land and water affected by operations. The high-risk sites are becoming increasingly common in the oil industry, and the environmental research effort must grow to satisfy this need alone.

I hope I have demonstrated that the petroleum industry is working to solve the environmental problems created by its activities. There is one other vital aspect of this problem which others have mentioned. However, it is so important that I feel compelled to include it, even at the risk of repetition. I'm referring to government regulation. In the past, the industry has been convinced that the less government regulation of business, the more successful the performance of the free enterprise system. On the question of environmental conservation, however, we have reached another conclusion. To avoid adverse effects on the competitive position of the environmentally conscientious company, we must all play by the same

*TOVALOP = Tanker Owners Voluntary Agreement Concerning Liability for Oil Pollution.

**CRISTAL = Contract Regarding an Interim Supplement to Tanker Liability for oil pollution.

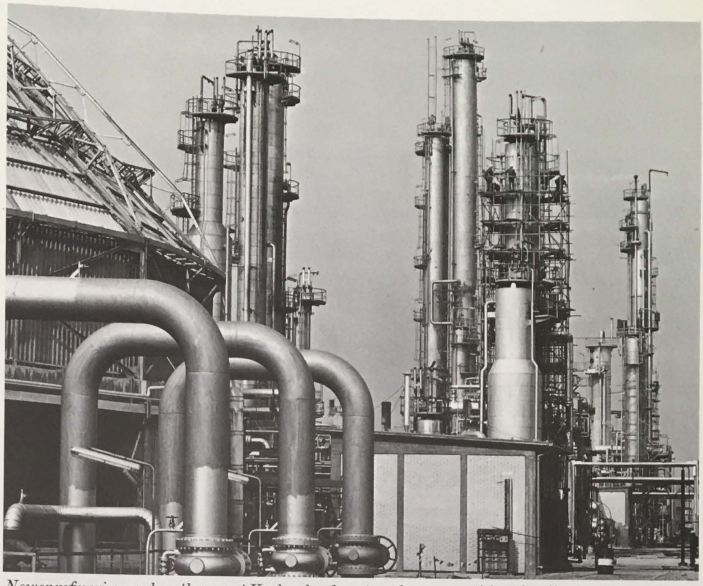
rules. Such uniform rules can only be established and applied by the responsible regulatory agency. I would hope that those rules, or regulations, can be worked out by a mutual effort of the government regulatory agencies and the industry representatives who are fully aware of the most efficient and least disruptive methods available to do the job.

If the technical resources and experience of industry are used wisely, they can make a great contribution to the selection of realistic and effective controls and timetables. The oil industry around the world stands ready to prove technical data on pollutants and many of us are ready to make manpower available to work with governments. In many instances, this is already being done. If government and industry continue to use and improve this basic technique of mutual consultation, we will greatly increase the likelihood of regulations that are fair, achievable, uniform for all companies in an industry, and successful for society as a whole.

In the pursuit of that continuing goal, society must expect obstacles. And this is one expectation in which I'm sure none of us will be disappointed! Ideal solutions take time to find, if they exist at all. While we all want them, we cannot wait for them. We must continuously make decisions on the basis of our present knowledge.

And in doing so, both government and industry must accept the chance that circumstances and technology may change. If that happens—and any man's experience will tell him it is almost inevitable—it is crucially important that we have the courage to alter our earlier decisions to reflect new conditions and technology. We must not only be inclined to more restrictive controls as we learn more about the environmental impact of our activities. We must also be prepared to remove or relax controls when new circumstances indicate this course of action—as politically distasteful as such actions might be.

Any discussion of environmental conservation finally entails the ultimate question: Who pays for it? We've all heard reference to the *"polluter pays principle."* This verbal shorthand is more notorious for what it doesn't say than for what it does say.

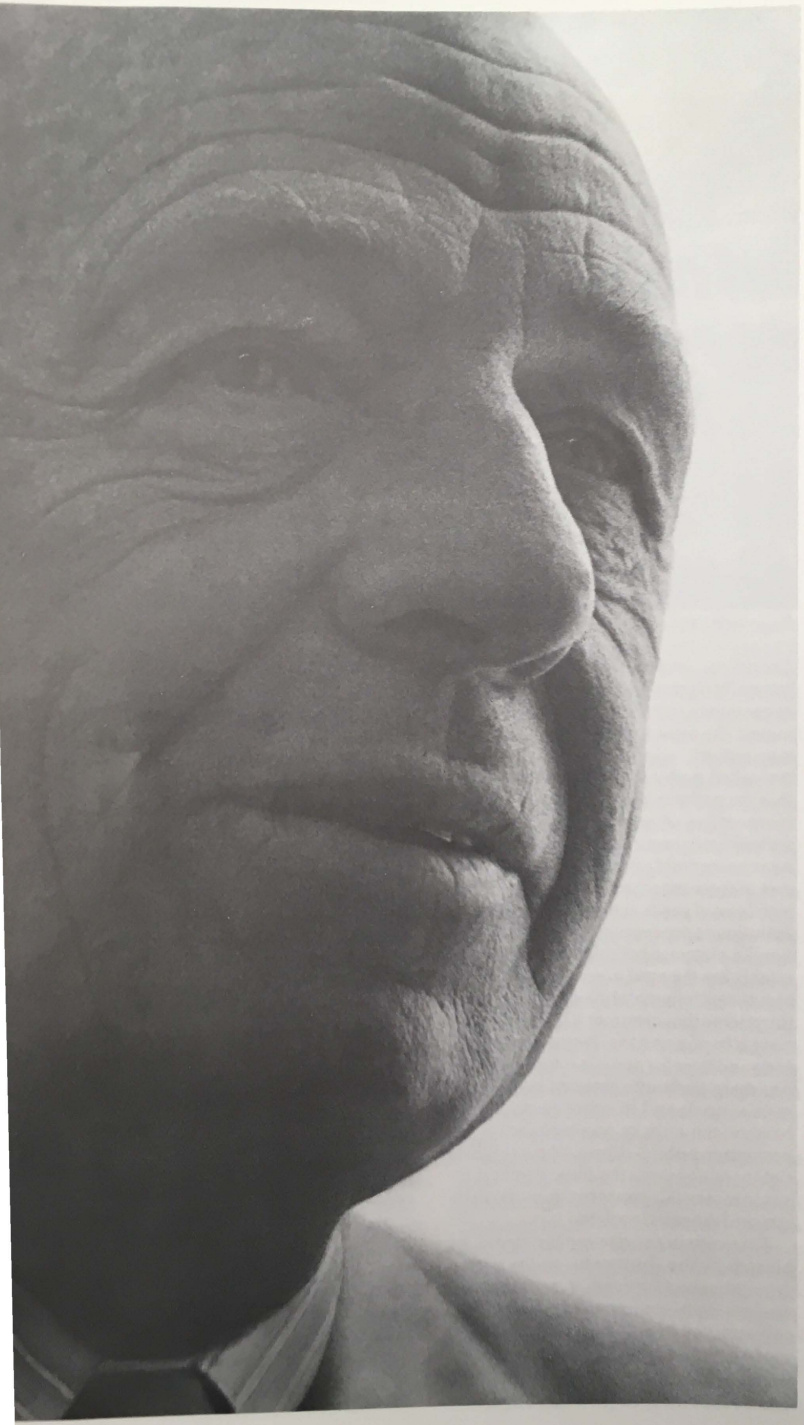


Newer refineries, such as the one at Karlsruhe, do not use large quantities of cooling water.

Therefore, while I believe the industry generally agrees with this principle, it is important to understand just what it really means. We would subscribe to the definition recently adopted by the OECD: the "so-called polluter pays principle means that the polluter bears the expense of carrying out the...measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and service which cause pollution in production and/or consumption." A statement of this principle clearly establishes the need to ensure that the full cost of environmental action is reflected in the price to the consumer. This is vital if society is to preserve the delicate balance of costs and benefits and if it is to achieve the necessary trade-offs between its environmental needs and its other needs. Such a balance can only be accomplished if the consumer public—those who are quite rightly establishing the basic demand for environmental conservation—is fully aware of the costs involved.

This consumer awareness would be blunted by the absorption, on the part of government, of any major portion of industry's own environmental costs. The polluter pays principle clearly would not support the use of any form of government subsidy for industrial pollution control. And for good reason. To do so would be to spread the environmental cost burden more thinly over the full taxpaying population rather than putting it directly on the consuming segment of the economy. Thus, the cost impact of control would be diffused and the risk of misdirected environmental action would be increased. Of course, there is room for some government subsidies, to ease transitions and in exceptional cases. However, large or long-standing government subsidies can delay installation of controls by creating the temptation for industry to wait in anticipation of government help. We need initiative, not procrastination.

The struggle to protect our natural environment has begun to make headway. Yet while this is an occasion for optimism, the rejoicing must wait. Very much remains to be discovered and done. As for my company, we are keenly aware of every inch of progress we make, so we know that there is a long distance yet to go. But with the oil industry's environmental expenditures approaching 10 percent of annual capital investment—and expected to grow still more—you can be sure the environment receives a good deal of attention from top management. Thus, the petroleum industry does have an attitude of positive realism which I feel is necessary if we are to meet the twentieth century's great challenge of continued growth in a healthy environment. ■



It is probably heresy to suggest that 'protec the environment' is becoming the leadin cliché of our times. Yet there has been *so* muc talk, *so* much emotion and not enoug rational action, that we are in danger o becoming bored with the subject of en vironmental protection.

That would be a tragedy, because this is one of the most urgent problems facing mankind. We dare not grow indifferent toward it, for it will be with us far into the foreseeable future. That is why I want to put down here in the plainest possible language exactly where Imperial Oil stands on the issue of environmental protection, and exactly what we expect of our employees.

We regard it as one of the most important matters facing the company. Protection of the environment is not a passing fad. Pollution will not go away by itself. Indeed, as population and economic growth increase, so will the potential for despoiling the land, air and water. This means that every person within Imperial Oil—not only the operating personnel, but every agent, every dealer, every office employee—has a responsibility in helping combat pollution of any kind. Preserving the environment is no longer just a good public-spirited thing to do. It is a *must.*

We will be listened to only if we practice what we preach.

The problem is not new to us. Imperial has been a leader in the pollution fight for many years. Usually we have been ahead of government regulations in our control measures. For example, in 1963 Imperial ordered its ships operating in the Great Lakes to retain food wastes and other garbage for disposal ashore. It was almost eight years before the federal government imposed similar regulations on all Canadian-flag vessels.

There are many other such examples, but this is no time for dwelling on past

Remarks by W. O. Twaits, Chairman, Imperial Oil Limited, Imperial Oil Review, *Number 5, 1972.*

Recently Imperial Oil Chairman W. O. Twaits appeared in a film to tell the people who work for Imperial what the company expects of them in the fight against pollution. Here, edited for print, is what he said.

the environment—whose responsibility?

achievements. It is a time for vigorous action. Society is calling for far-reaching legislation to protect the environment. This is particularly pertinent to our business because the oil industry has a relatively high potential to pollute both air and water. And we are not opposed to such legislation; on the contrary, we see the need for sound, uniform standards. But they must apply to all—it makes little sense for Imperial to spend millions of dollars controlling its operations if others in industry, or in the community at large, are not making a proportional effort.

Protection of the environment is not a passing fad. Pollution will not go away by itself.

Companies such as Imperial have experience that can be very helpful in drafting the new legislation. We have pioneered in environmental protection, have acquired much expertise and have much knowledge to contribute. Governments know this, and they welcome cooperation. But we will be listened to only if we practice what we preach. That is another reason why our performance as a company must be impeccable.

When I speak of 'environmental protection' I mean everything, large and small, from preventing oil spills in the waterways to cleaning up unsightly grounds and service stations. I mean not overfilling our own or our customers' tanks. I mean closer control over plant operations. I mean planning drilling and seismic operations so that we disturb northern tundra and streams as little as possible. I mean navigating, loading and unloading our ships with the utmost care.

Better equipment and design will help us. Our Strathcona refinery, which comes on stream in 1974, will be more than three times as large but will emit less contaminants to the air and water than the present refinery at Edmonton which is in itself meeting all government regulations. We are making great headway with such things as controls and telemetering in pipelines; new loading techniques for tank trucks to cut down emissions of hydrocarbon vapors; new technology that enables us to drill and develop in northern permafrost with minimal damage to the tundra.

Technology is only as good as the people who apply it.

But technology is only as good as the people who apply it. Our great concern is for better human performance. We need better work methods in every aspect of our operations, and although this is a primary responsibility of management at various levels, it goes right down to the individual. We must eliminate pollution incidents caused by human error, in the same way that we have worked at on-the-job safety.

Imperial Oil is committed to environmental protection as a way of life.

Everyone knows that safety requires total commitment. One careless act spoils the record. We need the same dedicated effort in environmental protection, with the same kinds of encouragement and the same kinds of accountability. Our company can't afford accounting errors, faulty products or lapses in safety procedures. And our company cannot ignore human errors that pollute the environment.

All of this additional human and technological effort is going to cost money. Imperial has already spent millions of dollars on preserving the environment and we will spend many millions more. We recognize that such spending is simply another cost of doing business in modern society.

In the past the world has used the environment freely, and never received a bill. Now we know that we must preserve that environment if future generations are to live, and that we must pay for it. Industry's expenditure is part of the total cost, and in the end it has to be borne by all of us—citizens and consumers.

But there is a limit even to expenditure. There comes a time—some industries have already encountered it—when the cost of protecting the environment for a proposed new venture may prohibit even starting that venture. This is why experienced companies like Imperial can help governments weigh the pros and cons in achieving realistic legislation.

Everyone knows that safety requires total commitment. One careless act spoils the record. We need the same dedicated effort in environmental protection, with the same kinds of encouragement and the same kinds of accountability.

And finally, no amount of money by itself will make the system work. Only people can make it work, and only if they are committed to it. This means every Imperial Oil person, from board room to service station. The whole chain breaks down the moment one person doesn't carry out his or her responsibilities. Frankly, we just can't afford to have that happen.

This won't be an easy task, and Imperial people are not to seek excuses for the difficulties or to try to convince themselves that the difficulties don't exist.

The difficulties *do* exist, and we must overcome them. For Imperial Oil is committed to environmental protection as a way of life. ■

CONCAWE-ten years on

Exxon's British affiliate is one of the six oil companies which in 1963 founded the International Study Group for the Conservation of Clean Air and Water in Western Europe, better known under its abbreviated name CONCAWE. On the 16th and 17th October, 1973, the Study Group celebrated its 10th anniversary, and organized on that occasion a session attended by representatives of the Commission of the European Economic Community, representatives of CONCAWE member companies, and delegates of the National Oil Industry Associations from various European countries. It is appropriate after the first ten years to review briefly the purpose, the origin, the development and the performance of CONCAWE, and to indicate Exxon affiliate's contribution to its activities.

As pointed out in the 10th Anniversary booklet issued by CONCAWE, it was long before the conservation of the environment became an issue of public concern that the oil industry recognized the necessity of being good neighbours to the community at large, and of taking appropriate measures to control and minimize pollution arising from its operations.

This need was felt independently and at an early stage by a number of oil companies, which realized that an ill-informed public could become a source of major difficulties for the oil industry. Individual oil companies had carried out studies of certain aspects of the problem and introduced measures towards effective pollution abatement. It was considered that cooperation between oil companies having these problems in common was desirable. This would assist in dealing with the various issues in the most effective and expeditious way.

During the period of negotiations preceding the official institution, Dr. W. J. Sweeney, President of Exxon Research and Engineering Company at Linden, New Jersey, who was a leading member of the World Petroleum Congress Council, undertook to get the official support of the Congress for the proposed new oil industry Study Group. This took the form of a resolution issued in May, 1963, welcoming and encouraging the work programme of CONCAWE, and recommending the discussion of environmental problems at subsequent sessions of the World Petroleum Congress.

With this wide and high level support of the oil industry, CONCAWE was officially established in October, 1963, and started its work according to agreed terms of reference, excluding all activities which would disclose company confidential information or impair in any way the competitive position of its members.

The objective of CONCAWE is two-fold. It covers both the collection and dissemination of scientific, technical and legal information on air, sea, water and soil pollution associated with the manufacture, transport and use of petroleum products. CONCAWE thus promotes active cooperation between participating companies to secure a flow of information and to provide work programmes and funds to develop better knowledge about the control of pollution. The results of this work and the considered views of the participants are made available to governments, international organizations, research institutes and other interested bodies.

CONCAWE, therefore, fulfils a dual role—first in gathering technical information, and secondly in disseminating the accumulative knowledge thus acquired. These two functions are a prerequisite for ensuring that pollution abatement technology is applied without undue delays and using the most efficient technology. By carrying out this work, CONCAWE also makes available to the responsible authorities the basic scientific and technical data they require to make decisions which both benefit the environment and are economically sound.

The governing body of CONCAWE is a Council on which each participating Company (six in 1963, and twenty-one in 1973, representing about 75 percent of the refining capacity in Western Europe) is represented. It defines the policy, and is assisted in day-to-day operations by a Secretariat located in The Hague. During its first years of operation the work of CONCAWE was concentrated on a number of issues which at that time were considered as most pressing. These covered the atmospheric dispersion of stack gases, refinery liquid effluents, the dispersion of oil in soil after spillage or leakage, the safe operation of pipelines in Europe, and the neighbourhood noise problem around oil refineries. For each of these issues a Working Group was established. Exxon's affiliate provided a Chairman for two of them, namely the pipeline Working Group and the noise Working Group.

The Working Groups are responsible for conducting their studies according to a programme approved by the Council, and for producing a final report on each phase of their work. By disseminating the work produced by both the Working Groups and the Secretariat staff, CONCAWE became known to many national and international bodies and, as time went by, an increasing number of requests for information on oil industry environmental problems were directed to CONCAWE. The most important international groups approaching CONCAWE are the U.N. Economic Commission for Europe in Geneva, the Council of Europe in Strasbourg, the Organization for Economic Cooperation on Development in Paris, and more recently the Commission of the European Economic Community.

Major contributions were solicited from CONCAWE by the UNECE when, in 1969, they organized a six-day seminar for government experts on the pollution of surface and ground water by oil and oil products. CONCAWE was asked to present a review of the "advanced techniques and methods used for the protection against failures of storage tanks and means of transport for crude oil and oil products." The Chairman of the Working Group on Oil Pipelines at the time, an Exxon employee, played the leading role in preparing this paper with the assistance of representatives of two other CONCAWE member companies. When the OECD initiated their Fuel Oil Sulphur study in 1969, they asked CONCAWE to produce cost figures on fuel oil desulphurization. When, in 1971, the OECD decided to publish a new issue of their periodic report on oil, they asked CONCAWE to write the section on the en-

The Automotive Emissions Laboratory at Exxon's research center in England.

vironmental implications of oil.

Among the various international organizations working in the environmental field, the EEC Commission is most important for two basic reasons. Firstly, they have defined a comprehensive environmental action programme which has been approved by the Council of Ministers; and secondly, their proposals, after approval by the Council of Ministers, are becoming Community legislation within the member countries. It is also the Commission that prepares the working documents for developing and processing this new legislation through the various steps, i.e. National Experts Groups, the Commissioners, and the Council of Ministers.

These working documents take into account, on the one hand, the current legislative situation or intentions of the member governments; and on the other hand, the various data provided by the studies the Commission has initiated and obtained from outside agencies. On different occasions they have approached CONCAWE to get expert advice on environmental problems of current interest, such as lead levels in gasoline and sulphur levels in fuel oil. It is of great importance for the oil industry to provide the requested information on each important issue to ensure that among the various studies the Commission is soliciting and considering there should be one which represents the views of the oil industry.

The growing public and official concern for environmental problems which has been noticed since the years 1969-1970 has resulted for CONCAWE in a growing number of enquiries. To cope with the increased demand, CONCAWE had to revise its initial organization consisting essentially of the five Working Groups mentioned earlier. They were substituted by five Advisory Groups covering the following aspects: air, water, noise, pipelines, and labelling. These embrace a much wider segment of the environmental scene that is of concern to the oil industry.

All participating companies are invited to nominate one representative to each of the Advisory Groups. These representatives are experts in the respective fields, and are capable of formulating the views of their companies in the relevant fields. The actual work on specific problems within each of the five specialized fields is carried out by Special Task Forces which can be established or disbanded according to the needs. These Task Forces are working under the supervision of a small Management Group elected amongst the Advisory Group members.

There are at present nineteen Special Task Forces in operation involving ninety-nine experts from participating companies, of which seventeen are Exxon employees. While actual technical work is carried out by company experts, CONCAWE provides the secretarial work and ensures liaison with the various outside groups. In this revised organization the Council retains its policy-defining function. However, it was felt that the more elaborate and diversified operations would require more guidance than previously.

For this purpose it was decided to elect among Council Members an Executive Committee of nine members for dealing with current problems and for managing the improved organization within the framework of the general policy. This new set-up provides greater flexibility of operation and a broader coverage of expertise which will hopefully suffice to cope with the various issues which arise. It has proved to be effective in dealing with the gasoline/lead and fuel/sulphur questions raised by the EEC during the past two years. The technical data CONCAWE was able to provide on these two major issues greatly contributed to the balanced approach taken so far by the Commission.

Regarding the future, there is no doubt that governments and international organizations will pursue their studies and actions towards environmental protection. Some of the issues will reflect specific and local concern of a small number of countries. Others will reflect more widely-spread concerns, such as automotive emission or waste oil disposal. These are part of the EEC environmental action programme. The latter, however, goes much further, and includes such issues as nitrogen oxides, refinery effluents, refinery siting, and the storage and transportation of potential pollutants. The plan of the EEC to propose a European Institute for the Protection of the Environment is an indication that Community activities in this field will continue to grow.

With support from its member companies, CONCAWE is in a good position to carry on the dialogue with officials, and to further contribute towards a sound understanding of environmental issues. ■

economics for environmentalists

It used to be that all we did with the environment was to live in it. We were aware of the environment only if we were enjoying a vacation on the beach or in the mountains.

Now, within a period of only a few years, we find ourselves preoccupied with the environment. We are reminded that we live in a spaceship, that everything is connected with everything else; we make environmental preservation and improvement a national policy and we pass sweeping legislation to accomplish it.

Some say we are going to extremes; others insist we must do still more. But whichever point of view you espouse, there are five basic considerations regarding the economics of environmentalism which should be borne in mind by anyone seeking workable solutions to environmental problems. Ignore these economic realities and regardless of what you hope to accomplish, you'll find you are creating new difficulties rather than solving existing ones.

Private corporations should not be expected to make social policy.

Some environmental groups argue that an electrical utility, for example, required to limit the sulfur content of its fuel to one percent, should get in the spirit of things and voluntarily use fuel with no more than 0.5 percent sulfur. The argument runs thusly: If we have an air pollution problem and the authorities have imposed a one percent limit as a means of alleviating it, the use of 0.5 percent should help things even more; and the utility has a public responsibility to do everything it can.

Note what this does: It puts the utility in the position of using its judgment to decide what is good for society. It costs more to use fuel with 0.5 percent sulfur than with one percent. So the utility imposes this cost burden on its customers—not because it has to but because it thinks it should.

The proper mechanism for deciding what is good for society and for imposing whatever cost burden this may entail is our governmental system with its elected officials. They are put in office for that purpose, and if the public disagrees with their judgment they suffer the consequences. The responsibility of the electric utility is to obey the laws and regulations adopted to carry out public policy—not to set that policy on its own.

This does not mean a private corporation should abrogate its public responsibilities, or that it should concentrate on interpreting or twisting the laws and regulations in a single-minded pursuit of the interests of its stockholders. Obviously, there are many areas in which a corporation can and must use its discretion. It should obey the spirit as well as the letter of the laws and regulations by doing all it can to assuage public fears through its actions.

Environmental decisions should involve a cost/benefit comparison.

Under the National Environmental Policy Act, this is already being done for major governmental actions which affect the environment. But it should also be applied to all actions taken to protect the environment. Federal, state, and local regulations should all stand the cost/benefit test. National legislation, also, should at some stage in its legislative history include cost/benefit considerations.

One of the great successes in the application of the National Environmental Policy Act—in the sense that the intent of the act was fully realized—was the recent lease sale on federal lands of the Outer Continental Shelf in the Gulf of Mexico. The original announcement of this sale last spring was challenged under NEPA. The result was that the sale was withdrawn while an environmental statement was prepared. The grounds on which the environmental groups brought suit was that the procedure called for by NEPA had not been followed, although the intent of at least some of those bringing suit was to permanently forestall the leasing. But when the environmental statement was issued the Interior Department was given the go-ahead and the environmentalists decided not to litigate further. NEPA's purpose had been fulfilled with what was, in effect, a demonstration that the benefits exceeded the costs, since those who had argued to the contrary conceded.

Actions of similar import, such as the imposition of a 0.3 percent sulfur level on fuels in New York City and other places, have been taken in the complete absence of any demonstration that the benefits of going from 0.5 percent to 0.3 percent exceeded the costs involved. It may well be that the benefits do exceed the costs, but on the basis of published information, no one knows. So the consumers of New York City pay additional millions of dollars yearly for their oil and for the electricity generated from it with no knowledge of whether the extra margin of reduction in ambient sulfur levels is worth it.

We should apply an economic calculus to environmental decisions just as we apply some kind of cost/benefit comparison to all other decisions.

Internalization of costs should be universal in making cost/benefit comparisons for environmental decisions.

What is internalization? It is economic jargon for taking into account external costs. And what are external costs? They are costs which are not recognized, or do not appear in the economic system. When you drive your car and thereby contribute to the smog, you are imposing a cost on your fellow citizens. It is not a cost, however, that appears in your car expenses. Or, as another example, an industry polluting a stream imposes a cost which appears downstream in the charges for municipal water treatment included in the consumer's bill. The industry, however, does not bear this cost. It simply uses the stream as a free way to get rid of wastes.

But when you pay more for your car because it has antipollution equipment on it and more for your gasoline because it is low-lead, and when the industry is required to treat the water itself so that there is a clean discharge, these costs, which were previously external to the system, have been internalized.

Here's another example. Environmen-

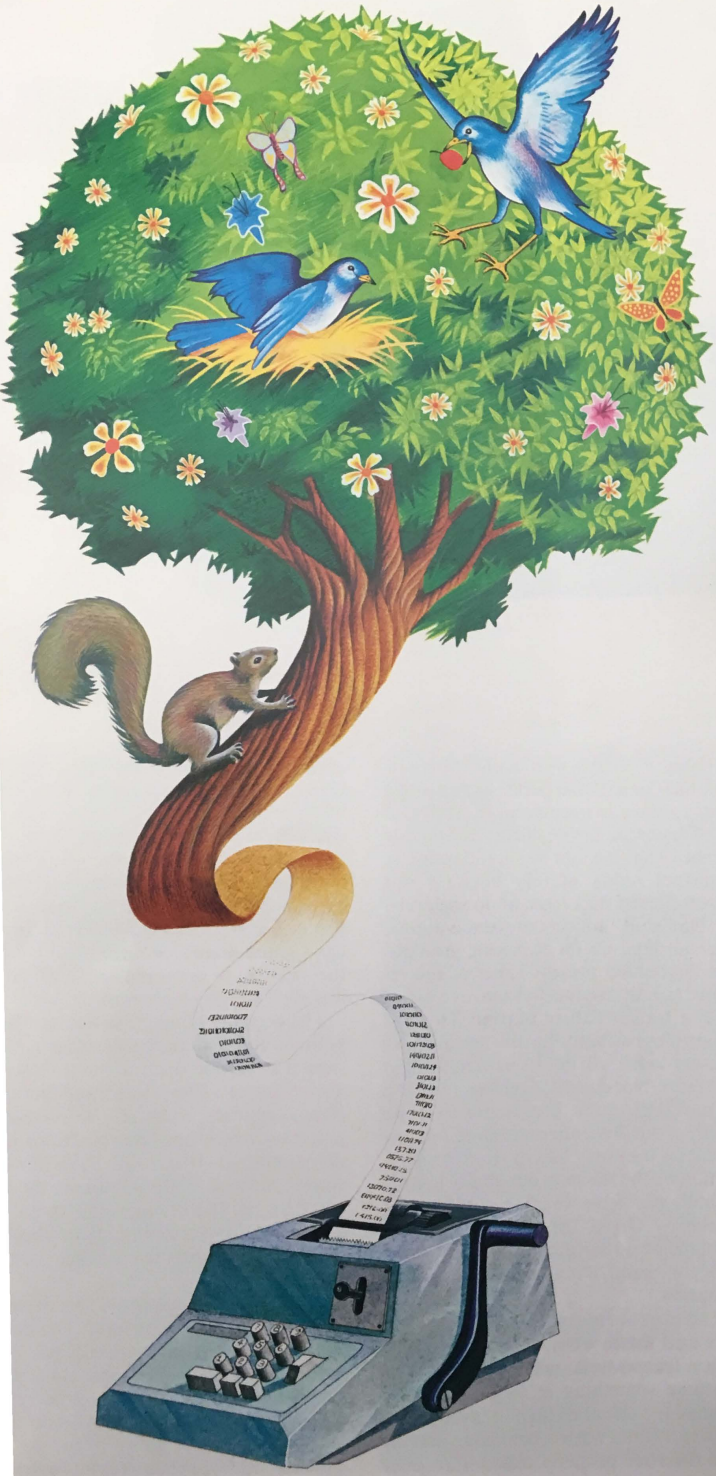
By Bruce C. Netschert, Exxon USA, *Second Quarter 1973.*

tal intervenors in nuclear licensing proceedings contend that in making the cost/benefit comparison, you should include the environmental costs associated with all phases of the nuclear cycle, beginning with uranium mining and carrying through to waste disposal. With this approach, the cost of operating a nuclear plant includes the health effects of radon on uranium miners, the environmental impact of the stack-gas emissions and thermal discharge from the central stations which supply power to the uranium enrichment plants, the risk of accident in the transport of nuclear fuel and wastes, and so forth. No problems, so far. But this is fair only if the same approach is taken with respect to the alternative fuels. To be fair, you should also consider an appropriate part of the fatalities in coal mining, the strip mining effects, the risk of oil spills in drilling and tanker operations, the air pollution from refineries, and so on, when comparing the costs of power generated by nuclear fuels to that of power generated by fossil fuels.

Do not bypass the market mechanism when that mechanism is capable of achieving the desired results.

Our market economy has two fundamental virtues: It works, more or less, and it is objective and impersonal. True, it has its imperfections and exhibits an annoying tendency to fluctuate in cycles. But by and large in most areas and most of the time it functions adequately. Anything we want to buy is available at a price which (within limits) reflects the cost to society of providing it. The price, moreover, is not set by fiat but by the complex interplay of supply and demand, as we all learned in our high school economics course. In the realm of theoretical economics, where everything works perfectly, exactly what is wanted is produced, at the minimum possible cost, and as the textbooks put it, satisfaction is maximized at the least expenditure of resources. To the extent that things are not perfect, resources are wasted, or, as the economist says, misallocated. But to the extent that perfection is approached, we are all better off.

Now, consider the proposal, made in the



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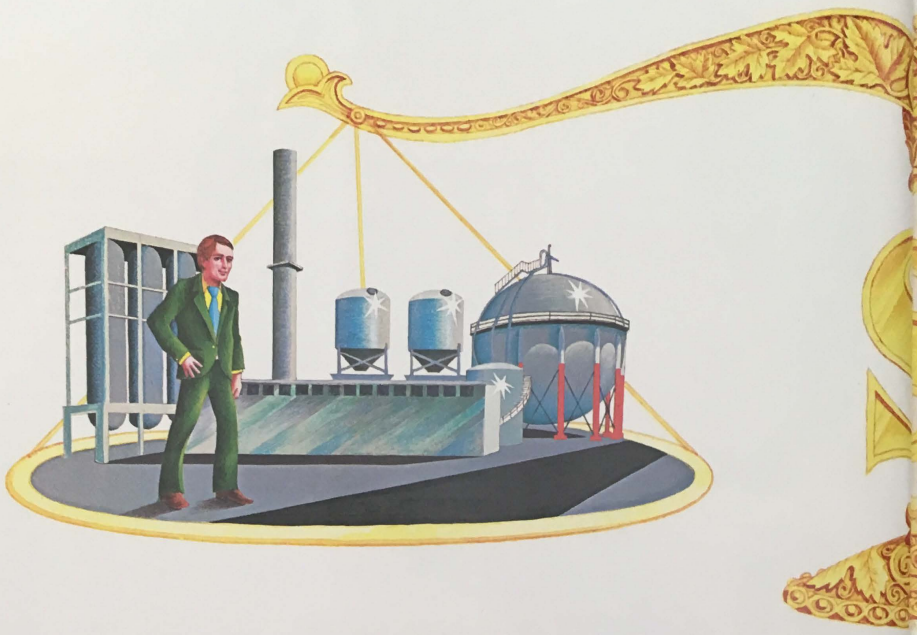


name of environmentalism, that curtailment in the use of electricity be made a social goal. The idea advanced by some is that this might be accomplished by taxing electricity so as to make it cost more. Why should we do this? First, says the environmentalist, because we are running out of domestic energy resources and second, because every kilowatt-hour means additional pollution of the environment, and making electricity more expensive will discourage its use.

This argument is faulty in that the first reason is wrong and the second results in the misallocation of resources. We are not really "running out" of energy resources. What has happened is that the ability of the oil and gas industries to satisfy the demands for their products is falling behind the growth in those demands. Our total energy resources, most of which consist of coal, are more than adequate. But beyond that, under the working of our system, no resource ever "runs out" in the sense that we suddenly come to the end of what we had. Rather, its increasing scarcity becomes manifest in increased cost, hence increased price.

"But," says the environmentalist, "if energy is getting scarcer we should conserve it for future generations." This might be desirable if energy were truly irreplaceable, like our national parks. But no single energy source is irreplaceable. Different forms of energy can be substituted for one another. The idea that we should conserve resources today merely because our grandchildren may have to do without—the "hair shirt" concept of conservation—does not hold up on economic grounds. The discounted present value of the resource rapidly approaches zero as we consider a longer future period. There is always the possibility that the resources we treasure today will not be needed at all in the future. Nor does the argument hold up on moral grounds. It assumes that the ability of our descendants to cope with the problems they may inherit from this generation will be less than our ability to cope with the problems we inherited from our forebears. Given the assuredly greater technological resources they will have at their command, it is an unwarranted presumption.

This does not mean we should be profligate and waste what we have in abundance. True waste is uneconomic. But if we consume something in large quantities because it is cheap enough for us to afford to do so, it is not waste—providing that the true costs are properly reflected in price and we are not less efficient than we can be. One of the reasons our oil resources have been depleted as far as they have is because there has been waste involved: The tax benefits enjoyed by the oil industry make oil cheaper than it otherwise would be, and therefore more of it is used. It is a waste to enjoy our high-powered, inefficient automobiles, because if we pay for the true cost of domestic oil we would be less able, as a society, to afford them.

The argument that every kilowatt-hour pollutes and that electricity consumption should be discouraged for that reason is also wrong. It assumes that there should be a zero polluting effect. But to be against pollution merely because you do not like it is insufficient. It has not been demonstrated that *any* pollution above the zero level is harmful. But supposing it were. It is still necessary to demonstrate that the benefit of removing it is greater than the cost of doing so.

Remember, the marginal cost of reducing pollution is not constant. The cost of each incremental reduction tends to be greater than that of the preceding increment. An excellent example is the reduction of soot and smoke emission from stacks. The cost of going from, say 99.5 percent to 99.7 percent removal is greater

than the cost of going from zero to 99.5 percent removal!

For the sake of argument, assume that a zero polluting effect should be attained. This will be very expensive. But if you are willing to pay the price in your electricity bill, why not consume electricity? The social costs have been fully internalized and you are not benefiting at the expense of someone else.

It comes down to this: The proper way to reduce or eliminate pollution is to internalize the costs of doing so. The environmentalist will say, "This may be very well for some aspects of environmental preservation, such as air and water pollution, but what about the siting problem? I don't want any more power plants built because they are taking scarce land which I believe is better used for other purposes." The answer again is that under our economic system the problem is taken care of in prices. As suitable sites for power plants become scarcer it means they become more expensive to the power company. You pay for that in your electricity rates. Admittedly, the price system alone can produce undesirable results. But this is now being taken care of, for nuclear plants, at least, by the NEPA procedure. As long as the benefits outweigh the costs, the argument has been settled, under the environmentalist's own rules. The same will shortly be true for all power plants.

The mistake in trying to discourage consumption of electricity through price manipulation is that it results in the misallocation of resources. Consider the various uses of electricity in which it is in competition (actual or potential) with the fuels. We can heat our houses with electricity, or we can do it with oil, gas, or coal. We can heat our water and cook with electricity, or we can do the same with oil, gas, or coal. Now, if electricity is artificially made more expensive it will not mean that the demand for electrical energy will disappear; demand will merely be transferred to the fossil fuels. More economic resources will be devoted to making them available in the quantity necessary to satisfy the demand. But this is a misallocation, since the only reason the additional economic resources are being utilized in this manner is because of the price change. Under "normal" circumstances fewer economic resources would have been required to satisfy society's needs.

Recognize that there are no absolutes. The environmentalist who says he wants no further expansion in energy use and never mind the consequences is not engaged in rational argument but is giving vent to his emotions. The same can be said for the position that there should be no more offshore drilling for oil and gas, as well as for the proposition that nuclear plants should be built only if it can be guaranteed that there is no accident risk. It would be pleasant if all of these things could occur, but we must live in the real world, not the world of fantasy. The great majority of the public is not interested in cutting off growth in energy use if it means going back to bicycles and doing without air conditioning. We don't live, and never have lived, in a world of zero risk; we attempt, insofar as we can, to reduce those risks over which we have any control to a reasonable minimum.

In no way do these economic considerations frustrate the realization of economic goals. We *should* lessen the pollution we are causing and, to the extent present energy consumption levels are the result of inefficiency and waste, we *should* reduce energy use. It is only when we apply illogical standards and unrealistic value judgments, and only when we substitute emotion for reason, that we most seriously jeopardize the cause of environmental conservation. ■

bugs, boilers, and goldfish

Not long ago, conservation coordinators from Exxon affiliates all over the world gathered in New York to discuss various environmental problems, report on the antipollution measures they have taken in their own areas, and to exchange ideas and technical information on the additional corrective measures that are still needed. M. M. Brisco, Exxon's president, addressed the group and put the environmental picture clearly into focus:

"It is an inescapable fact that our business touches the physical environment at every single step—from initial exploration through production, transportation, refining, and marketing—and further, to include the use of our products by our customers. We can take no comfort from the fact that other industries, government, and individual citizens are also polluting. Our own record must improve. No affiliate is exempt from this responsibility."

What are Exxon's affiliates doing to meet this responsibility? Following is a progress report on some of the conservation projects that have been put into effect at affiliates' refineries.

Take, first, water conservation activities. There is a project for the "changing of the water," as they call it at the Baton Rouge refinery of Exxon Company, U.S.A. The purpose is to reduce the amount of river water needed for cooling by means of a closed recirculating system.

As recently as 1970, the Baton Rouge refinery discharged 190 million gallons of effluent a day, consisting mostly of Mississippi River water that was used on a "once-through" basis for cooling at process units. Now the discharge rate is down to 20 million gallons a day. That reduction of 90 percent has been achieved by piping water, which formerly would have been sent back to the river, to ten tall new structures distributed around the sprawling refinery. Some of these cooling towers recirculate as much as four times the volume of water that is eventually discharged into the Mississippi. Cooled by air at the atmospheric temperature, the water enters a tower at 130 degrees Fahrenheit and leaves it at 80 to 87 degrees. Moreover, the amount of oil contained in the water effluent has been reduced by 95 percent. This has been accomplished by making several changes.

One was to clean up 325 waste-water streams that flow from and between various units within the 900-acre expanse of the refinery. Engineers and technicians painstakingly tracked down sources of pollutants in each stream and then devised methods of removing them. But the problem still wasn't completely solved, and several processes are presently being tested as a secondary treatment step to further reduce emission of contaminants.

Robert Denbo, the senior staff engineer in charge of pollution-control planning at the refinery, explains why the Baton Rouge system is so effective: "Abatement combined with source control is the key to solving the problem of returning clean water to the river." But that is not the entire story. "Management," according to Mr. Denbo, "has reacted to pollution problems much as concerned citizens do. Their concern, in turn, has spread to all our people at operating units. Just about everybody in this refinery is working on these projects in one way or another."

There are billions of pampered bugs at Exxon's Bayway refinery in Northeastern New Jersey. The "bugs" are actually countless varieties of microorganisms, including microbes or bacteria. They live in two lagoons, each about the size of a football field, where they flourish on a diet of crude oil and organic materials.

In refining about 200,000 barrels of crude oil a day, Bayway uses 15 million gallons of process water. Most of the pollutants are removed from the water by separators, skimmers, and stream stripping units, but some dissolved organic compounds remain. So the waste water is then pumped into the lagoons where whirling blades stir in the oxygen necessary for the survival of the microorganisms. The hungry bugs go to work, gobbling up the organic chemicals—and sometimes each other when very hungry—and converting the pollutant material into harmless carbon dioxide and plain water. The effluent drains into a settling tank where the microorganisms sink to the bottom. Clean and clear water is returned to Arthur Kill, the channel that separates New Jersey from Staten Island.

This water-purifying process, known as biological oxidation, is now used at many of the refineries being operated by Exxon affiliates.

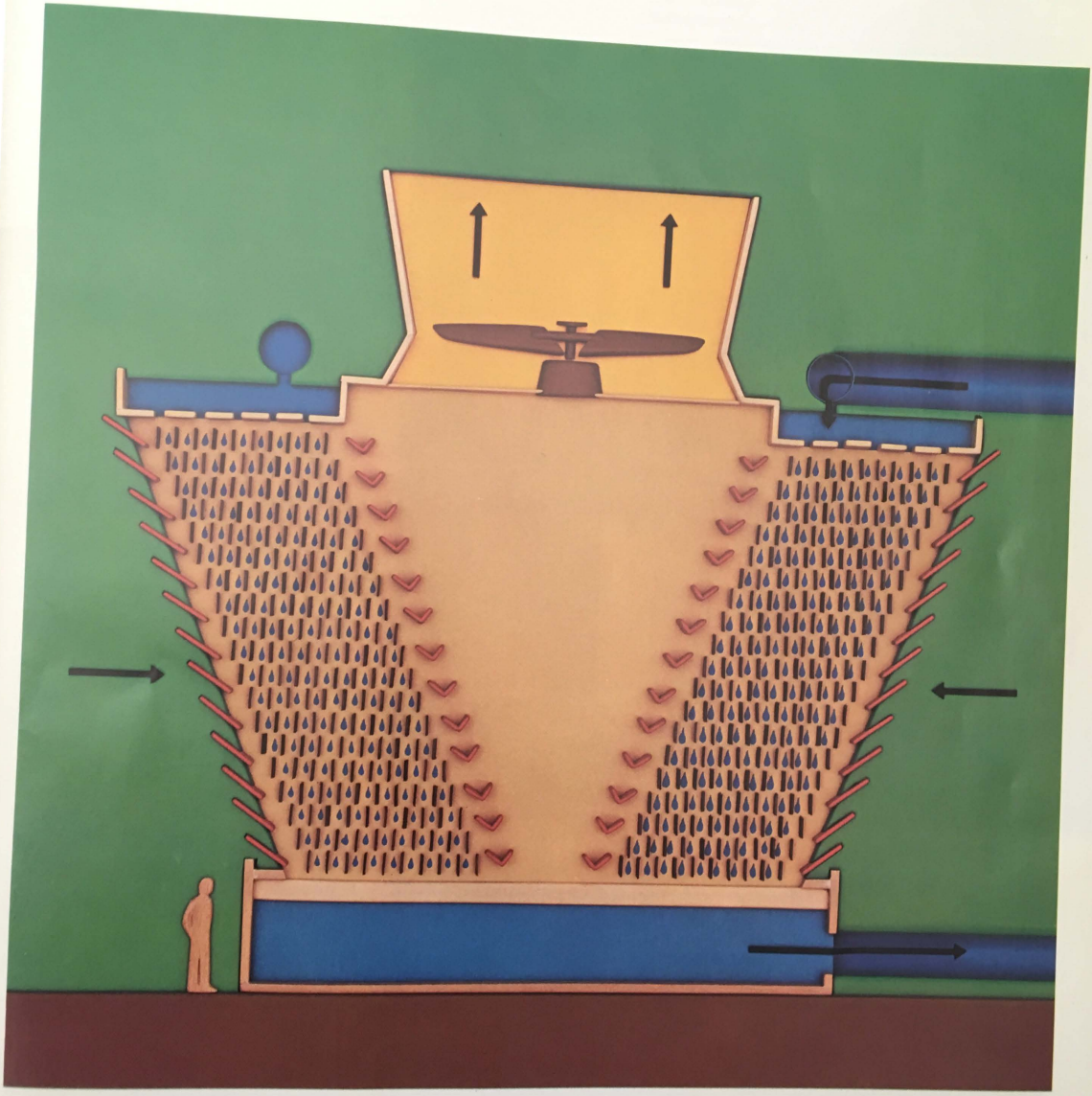
At Exxon's refinery at Baytown, thirty miles east of Houston, goldfish in an aquarium play an important monitoring role. The water passing through the gills of the darting fish has previously gone through processing units. It is a random sample of the 20 million gallons of water that are used and treated at the refinery and returned to the Houston Ship Channel every day. Another 800 million gallons, used for cooling and steam generation, are recycled. At latest report, Baytown's goldfish are healthy and eating regularly, which would indicate that the water-treatment system is working well.

No less than ninety-four full-time employees at Baytown make sure that it does. Their job has been helped along by twenty-eight oil-water separators at processing units. The separators send oil right back to the unit involved or to another one. If oil wastes by chance slip through several preseparators at the end of the refinery's sewer systems, they are almost certain to be removed by a master separator. And if that fails to do the trick, biological oxidation takes over. Bacteria have a full fifteen days to feast on and digest minute particles of oil while waste water passes through three different lagoons. Only then does Baytown's effluent go into the Ship Channel—and to the aquarium for monitoring.

Contaminated effluents from industrial plants and cities are a major problem along the course of Europe's Rhine River

By Richard Rutter. The Lamp, *Spring 1972.*

Exxon affiliates worldwide are making coordinated efforts to reduce environmental pollution at their refineries. Advanced technology and large capital investments are bringing solid progress.



Giant cooling towers are the heart of the river water replacement project at Baton Rouge refinery. Some of these towers recirculate as much as four times the volume of water that is discharged into the Mississippi River. The result has been to reduce the refinery's total effluent by 90 percent. The Mississippi River is a major source of drinking water for a million-and-a-half people.

Activated carbon is one of several processes being used on an experimental basis to filter out pollutants from waste-water streams that flow from and within the 900-acre expanse of the Baton Rouge refinery. Engineers and technicians painstakingly tracked down sources of pollutants in each stream and devised methods of removing them. The problem isn't completely solved, but efforts continue.

and its tributaries. The problem would be closer to solution if there were more water treatment facilities like those in use at the refinery operated in Karlsruhe, West Germany, by Exxon's West German affiliate. Liquid wastes from the refinery operations are collected and treated in four separate systems. Solids and oils are removed by mechanical skimmers, sedimentation, and biological oxidation. Water returned to the Rhine contains only one part of oil in a million parts of water. Similar techniques are being used at the affiliate's refineries at Ingolstadt and Cologne.

More than a quarter of a century ago, *The Juicy Scoopy*, a converted lifeboat, played a major role in pollution control at the Sarnia, Ontario, refinery of Imperial Oil Limited, Exxon's Canadian affiliate. Alex McRae, an Imperial chemist, was wont to cruise the adjoining St. Clair River in the boat, collecting samples of river water. He used the water to make tea, which magnifies the bad taste of undesirable chemicals, such as phenols. Mr. McRae's unorthodox tests and early work on pollution control helped Imperial clean up refinery waste water in Canada.

Many refineries are busy ports as well as industrial installations, and precautions have been taken to avert oil spills during loading and unloading operations by intensive training of ship and shore personnel. If an accidental spill should occur, a rapid and effective cleanup becomes an urgent matter.

Exxon's refinery at Bayonne, New Jersey, is a case in point. As many as 60 ships and 500 barges tie up in the peak months, and at least 100,000 barrels of oil a day cross the docks. A "spill brigade" of operating personnel, laboratory technicians, ship and office workers has been trained to respond quickly to an oil spill before it can spread. A sixteen-foot Boston Whaler craft is stored on a trailer for use on the waterfront, where davits have been installed for fast launching. About a thousand feet of boom to contain oil on the surface of water are also kept in constant readiness, along with a floating skimmer pump that picks up liquid at the rate of 350 gallons a minute. Similar special spill cleanup teams are now common at Exxon installations.

To a great extent, effective pollution-control measures depend on people—the cooperation and dedication of employees without which all the devices in the world would be ineffective. Environmental committees have been formed at many Exxon refineries in order to assure that operations are conducted to minimize the effect on the environment. These committees meet regularly to review environmental performance, set performance targets, and communicate them to the operating staff.

Air conservation activities are also being stressed. There are units at many refineries designed to recover sulfur daily by converting hydrogen sulfide into sulfur. Hydrogen sulfide results during a process that lowers the sulfur content of heating oil. Converting it into elemental sulfur keeps a potential malodorous pollutant out of the atmosphere. At the same time, heating oil is provided that meets the strict low-sulfur requirements now found in many areas.

The Exxon refinery at Billings, Montana, has a cleaner-air program that in-

cludes a $1.4-million, two-story boiler which burns up most of the carbon monoxide and a large part of the particulates emitted from a big coker unit. So far, the boiler has been able to reduce carbon monoxide emissions by 98.5 percent and particulates by 67 percent. As it burns these pollutants, the boiler produces an enormous amount of heat which is siphoned off and used as energy in making various products.

Evaporation from tanks can be a pollution problem at refineries—particularly older installations—and here, too, Billings has acted. Five tons of hydrocarbons that once evaporated into the atmosphere each day are captured in storage tanks with floating roofs. The roofs literally float on top of products in the tanks, eliminating vapor space and, consequently, evaporation. Floating roofs have been installed at the storage facilities of all Exxon refineries in recent years. The installation of a dust collection system at storage and loading facilities is expected to cut coke particulate emissions by another 27 percent at the Billings refinery.

Imperial led the way in Canada in installing smokeless flare tips on stacks at its refineries. The flares are made smokeless by means of steam jets that mix air with escaping gas so that it burns completely. In addition, these stacks are monitored continually from a control room by television cameras to make sure that the flares are working properly.

When Exxon's new refinery at Benicia, California, went on-stream in 1969, it incorporated just about every type of conservation device and measure then known. Some $10 million was invested in special equipment to control air and water quality. The refinery was carefully designed as an exercise in total environment planning. That even included painting the facilities in a soft green and yellow-gold to blend with the surrounding landscape.

Preservation of the natural environment was also a major design feature when Exxon's refinery at Fawley on the south coast of England was planned. A broad belt of trees and shrubs was planted around the environs to shield the facility from the unspoiled countryside. Many kinds of wildlife thrive within the confines of the large refinery grounds. Their natural habitat has remained intact.

The battle to protect the natural environment is a never-ending one, and, naturally, it involves constant forward planning, both short- and long-term.

Just last fall Imperial announced it will spend more than $200 million over the next three years to build a new petroleum product supply system. The heart of the project will be a refining complex to be built on the site of the company's present refinery at Edmonton. The Imperial refineries in Calgary, Regina, and Winnipeg will be phased out as new product terminals go into service at those centers. W. O. Twaits, Imperial's chairman, emphasized that environmental protection was a basic factor in the decision to build the new supply system and to concentrate refining facilities at one location. A large part of the cost will go for facilities to produce low-lead and lead-free gasoline, while $13 million will be spent directly on pollution-control measures and equipment.

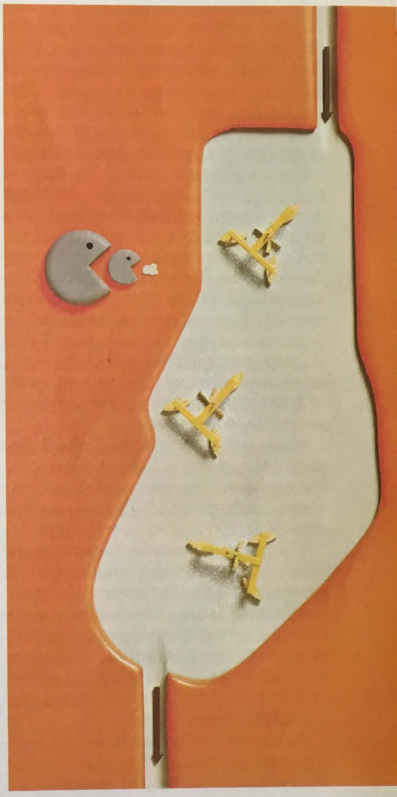
Like many refineries, Fawley in England must expand in the years ahead to meet the ever-growing demand for fuels and chemicals. With that in mind, Exxon's British affiliate asked J. St. Bodfan Gruffydd, president of the Institute of Landscape Architects, to examine various methods of preserving the "visual and recreational amenities" of the area during the period of expansion. The distinguished architect recommended a sweeping program of reclamation and landscaping which will cost between $2.8 million and $5.6 million and extend over the next twenty to twenty-five years. The affiliate plans to reclaim between 400 and 500 acres of the foreshore in successive stages and will make extensive additions to the existing tree and shrub belt.

In the United States, Exxon USA expects to invest more than $100 million by 1975 to further improve the control of pollution from its refineries.

Exxon is fully aware that the battle to protect the environment, despite discernible progress, is far from won. The company's own goals and some legislated standards have yet to be met. The future requirements will almost certainly be greater, as will be the cost of meeting them. But there is really no choice. M. M. Brisco, in his remarks to the affiliates' conservation specialists, came directly and succinctly to the point:

"From the first seismic shot to the final consumer, the oil business is a very environmentally sensitive business. We can no longer deny, defend, or disregard our free use of the environment. We must find the ways and means to make our operations and our products compatible with a clean environment." ■

Many refineries have biological treatment facilities. Microbes in lagoons feed on organic chemicals—and sometimes each other—in waste water. Aerators churn up water and stir in needed supply of oxygen. Clean water is discharged after settling.



Exxon USA and Benicia: getting it together

To residents of the small San Francisco East Bay community of Benicia, just stirring awake that spring morning in 1962, the announcement was an unexpected shock.

Bannered on page one of the Vallejo *Times-Herald,* five terse words told the story: *Pentagon to Close Benicia Arsenal.*

For more than a century, the array of high-windowed, fortress-like buildings dotting the town's hillsides *was* Benicia, in the minds of many, the mainstay of the community's existence. Opened during the 1849 Gold Rush, the U. S. Army Arsenal had spread over the years from its original 252 acres to more than 2,700. In four wars, it had shaped, stored and shipped literally millions of bullets, shells, bombs and rifles; by 1962, with a payroll of 2,100 persons, it was Solano County's second largest employer.

Now, after 115 years, the Defense Department had ordered the arsenal closed for economy reasons, and Benicians winced at the prospect. In 1964, the historic old facility shut its doors forever.

"The arsenal, consisting of government buildings, government equipment and government land, was never a tax base," recalls James Lemos, a Benicia resident 58 years and currently serving as mayor, "but as an employer, it meant practically our whole economy. When the axe fell, a lot of us feared that bankruptcy waited just around the corner."

Despite the predictions, Benicia today is very much alive and well; since 1968, it has enjoyed an unprecedented prosperity, an economic boom exceeding anything in the city's memory.

Exxon Company, U.S.A., which began operating a $170 million, 400-acre refinery in Benicia in 1969, has shared substantially in the community's success story.

By Joseph E. Brown, Exxon USA, *First Quarter 1973.*

The refinery, one of the world's most modern, represents a major portion of the Benicia tax base, provides jobs, was the catalyst for a series of events which touched off the Benicia boom in which it has been a partner.

Benicia's population is now heading towards 10,000—up 3,000 from 1964. The school system has expanded. A modern shopping center—first in Benicia history—opened in 1971 not far from a century-old, two-story building, now restored as a state historical monument, which served as California's first capital. Modern split-level homes, commanding a view of both Benicia and the historic Carquinez Strait beyond, are proliferating in hilly Southampton, Benicia's first subdivision.

"We've also been able to increase police and fire protection," says Mayor Lemos, "and, with a substantially increased budget, we've improved long-ignored city 'fringe' services, such as recreation."

Just as important, business leaders emphasize, in the years since 1964 Benicia has added 80 industries with a combined payroll of 2,400—300 more than the arsenal employed at any time except its World War II peak.

None of the sudden civic boom happened by accident, of course. "What happened," beams Lemos, "was that a lot of us decided that while we were down, we were far from out. We simply looked for ways to put Benicia back on its feet."

First, negotiating with the federal government, Benicia leaders acquired the arsenal buildings and site; altogether, 2,200 acres were designated as the Benicia Industrial Park. Then a campaign was launched to attract industries. Today, 80 park tenants turn out a variety of products ranging from plastic signs to bed frames, from auto accessories to retread tires. And because they are rooted in the private sector of the economy, the companies generate tax dollars the arsenal never did.

For some time prior to 1964, Exxon USA had been seeking a West Coast site suitable for a modern refinery, one geared for "high severity" operations to serve an expanding western market.

"High severity," explains Robert E. Naugle, the refinery's operations manager, "means an operation which converts a high percentage of the crude oil received into gasoline components. At Benicia, we planned to make no heavy liquid fuel oils, no oils of the bunker fuel type."

Benicia Refinery was to be designed and built with maximum effort to prevent damage to the surrounding air, water and land. And its color scheme—green and gold—would lend harmony as well.

A Palo Alto, California, consulting firm was retained to study wind currents in the

area. Technicians released dozens of balloons, noting which way the wind currents carried them. The resulting data helped determine the location of both the refinery's main stack and related equipment, and air monitoring stations.

To conserve a natural resource, Exxon USA installed air cooling systems which work on the same principle as an automobile radiator. As a result, the refinery's water demand is about 10 percent that of a conventional refinery.

Another consideration in planning the refinery was that a suitable work force was available, or could attract employees from elsewhere. Of the 350 currently on the refinery's payroll, about half live in Solano County, many in Benicia.

During the design period, Exxon USA worked closely both with Benicia civic leaders and with officials of the Bay Area Pollution Control District (BAAPCD) and, although the refinery was not at that time within the district's jurisdiction, nevertheless agreed to meet district air quality emission standards.

Before the first spadeful of earth was turned, for instance, Exxon USA invited BAAPCD representatives to monitor environmental studies, and offer suggestions. BAAPCD personnel were involved in reviewing the results of the wind current studies, critical because the data they provided would help locate such facilities as the flare stack, main stack and air quality monitoring stations.

Of $170 million invested in the refinery so far, over $17 million has been spent for pollution control equipment, including backup equipment where needed. Of the total the largest slice—$11 million—was devoted to air quality equipment. The rest went to insure that water quality would be maintained.

Exxon USA operated four other refineries before Benicia, yet Benicia presented a totally new challenge.

"What is important to remember," points out Frank Chadwick, present Benicia Refinery manager, "is that a refinery must be designed, built and operated for a specific site, a specific task, with specific environmental considerations in mind. The type of crude oil processed varies from one refinery to another; so can regulations to which the refinery is subject."

Ground was broken in October, 1966; by January, 1969, the first component of a sequential "phase-in" system was rolling in high gear, busily converting up to 72,000 barrels of crude oil daily into motor gasolines, jet and diesel fuels, and coke.

Up to that time, the refinery was subject to laws of nine regulatory agencies. In 1971, a tenth was added, when the BAAPCD extended its boundaries to include Benicia. The regulatory agencies are tough and the refinery, though "clean" as compared to standards of just a few years ago, has been taken to task in the form of citations and even fines. However, the intent of the company is to work diligently with these agencies to improve operations and to meet the regulations.

The regulations change, too. In 1971, the BAAPCD board voted to modify one of its enforcement rules, one that toughened maximum allowable emissions of industry. On BAAPCD's books, the change could be explained in a few inches of type. But to Exxon USA (and other affected industries), it required a period of intensive replanning, reconstruction—and an investment then estimated at $2.7 million.

James Lemos, who as Benicia's mayor also holds a seat on the BAAPCD board, explains the tempo of the period. "All over the Bay Area," he remembers, "people were becoming increasingly concerned about their environment. There were more than 100 environmental groups organized in the several counties bordering San Francisco, ranging from the national headquarters of the Sierra Club, one of the world's oldest and largest such groups, down to small neighborhood groups of concerned citizens. It was the Age of Ecology, and they were quite vocal about what they wanted: tougher antipollution laws."

The new BAAPCD rule involved a stricter standard of an emission measurement system commonly called the Ringelmann Scale. Developed originally so that industries could measure efficiency of steam boilers, it grades opacity or density of emissions on a scale of zero to five, representing opacity levels of from zero to 100 percent. Previously, the BAAPCD had established Ringelmann Number Two (40 percent opacity) as the maximum allowable emission. Under the new rule, Ringelmann Number One (20 percent opacity) became law. BAAPCD enforcement officers, trained at special "smoke schools," determine opacity levels by visually sighting plumes.

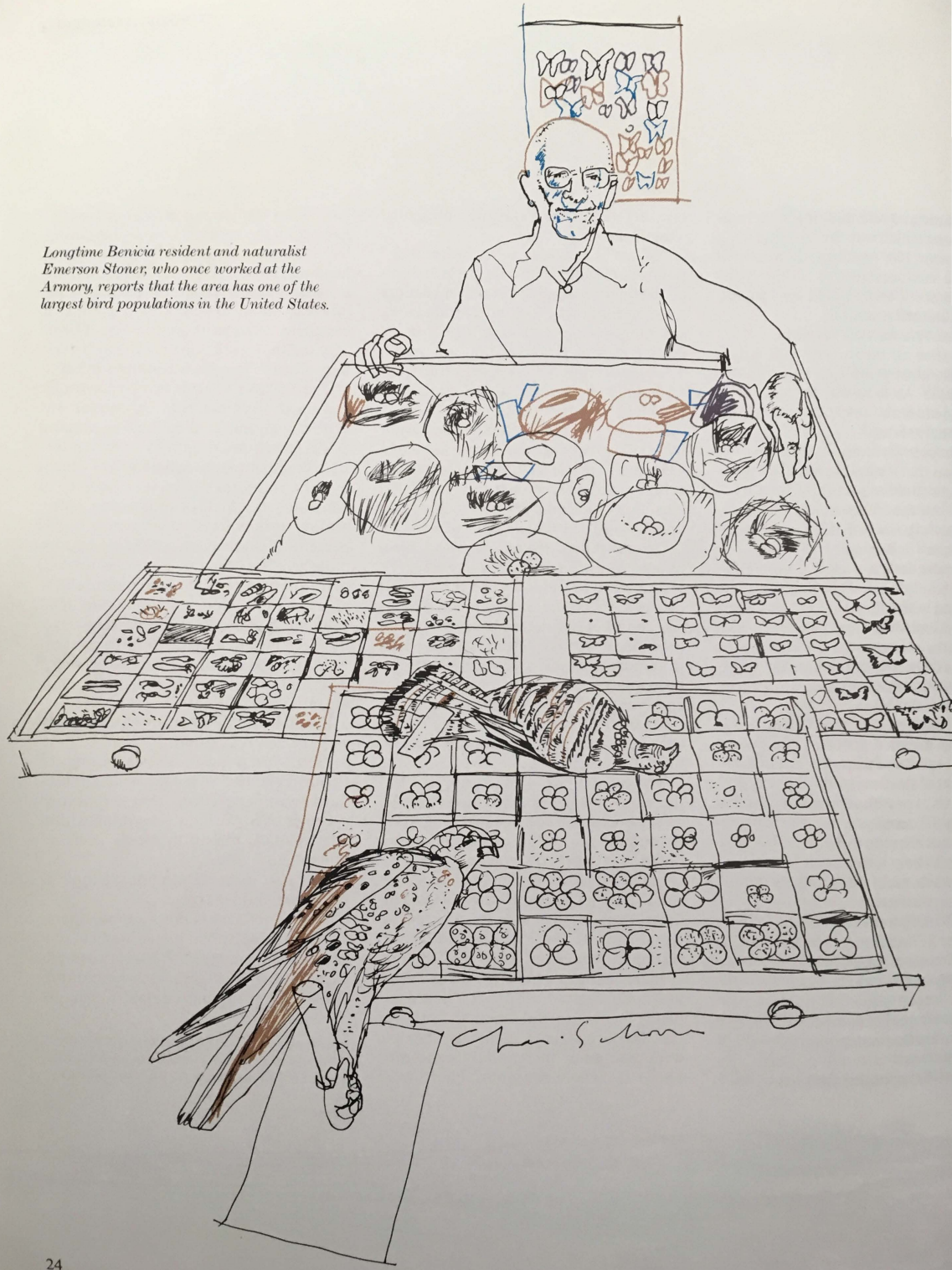
Exxon USA moved promptly to comply with the new regulation.

"It is our policy," Benicia manager Chadwick states, "to comply with all standards and regulations that regulatory agencies pass. We'll do everything within our technical ability to satisfy such requirements."

Doing so, however, was not as simple as the layman might expect.

"An oil refinery is not a simple operation," explains Robert E. Lee, Benicia staff and services manager. "It is a very complicated network of interlocking components. The planning required to comply

Set amid rolling hills on the shores of Carquinez Strait, Benicia found a solution to its woes and Exxon USA found a site for a needed refinery.



Longtime Benicia resident and naturalist Emerson Stoner, who once worked at the Armory, reports that the area has one of the largest bird populations in the United States.

with regulations *before* a refinery is built is one thing; doing it *within* an existing plant is a severe challenge, especially within a tight time frame."

He cites a specific example. "Benicia's main stack, 465 feet high, 15 feet 6 inches in diameter at the top, was positioned and its height selected on the basis of Ringelmann Number Two standard. The new regulation—Ringelmann Number One—is very difficult to 'make.' The wider the stack, the wider the visible plume, and the more difficult our job becomes in reducing the density of the emissions to comply with the Ringelmann change." The stack obviously could not be torn down and replaced. It required, instead, on-the-spot technology.

Chadwick puts it another way. "What we were faced with was finding solutions for today's air pollution problems with tomorrow's technology. There's a technological time lag between the research period and the point where we can construct and put new equipment into operation. Constant changes in the regulations make it difficult to determine which technology and air protection equipment should be developed and installed."

Exxon USA, however, had known that air pollution standards were being toughened across the country. "At Benicia," Chadwick explains, "even though we began research for designing increased air quality protection in 1970—nearly 18 months before the BAAPCD enacted its new regulations—we could not meet the compliance deadline of October, 1972. We are currently operating under a variance until our present improvement plan is completed this fall."

In processing crude oil, an impurity such as sulfur must be removed from the crude as it goes through four basic processes of distillation, conversion, treatment, and blending into new components. This sulfur is recovered. A big slice of the improvement plan investment—$1,300,000—was spent on these sulfur recovery operations to reduce visible emissions from the refinery's main stack and flare stack.

At a cost of $1,200,000, a 115-ton tertiary cyclone was added, reducing catalyst

First U.S. military bastion in California, the Armory was Benicia's economic mainstay until it was closed in 1962. Dr. Charles Eldon Davis (bottom), pastor of historic St. Paul's Church, welcomes the annual participation of refinery personnel in the church's nationally famed "Peddler's Fair."

in flue gas from the refinery's fluid catalytic cracking unit. Cyclones represent one of several steps employed by refineries to remove pollution-producing particulates before they can enter the air. They spin gas very rapidly; the centrifugal motion separates the particulates from the gas before they leave the unit.

Meanwhile, welders crawled into the refinery's electrostatic precipitators—huge, boxlike structures—to weld a series of new curved steel plates into place to improve air flow. In a precipitator, electrically charged particles are attracted to plates; then they are dropped out the bottom and hauled away. Cost: $50,000.

Although the stack emissions were improved, test work concluded that additional cleanup was necessary to fully meet Ringelmann Number One. An extension of the variance was granted, and two additional electrostatic precipitator cells are being installed in parallel with the three existing cells to further reduce plume visibility from the main stack. Cost: around $1.7 million.

Finally, $150,000 went for changes to reduce visual emissions at the refinery's coke loading operation.

When the work is complete, the early estimate of $2.7 million will have increased to about $5 million to achieve Ringelmann Number One under normal operations as the BAAPCD required. And while the changes were necessary to comply with both regulations and Exxon USA's traditional concern for the environment, they suggest three points not always understood by the public:

> Not a cent invested or an hour worked will increase production of petroleum products at the Benicia Refinery.

> Technological antipollution knowledge gained in the process cannot necessarily be applied to other refineries at other locations.

> Eventually, at some point in time, increasing costs of pollution control must be passed on to the consumer.

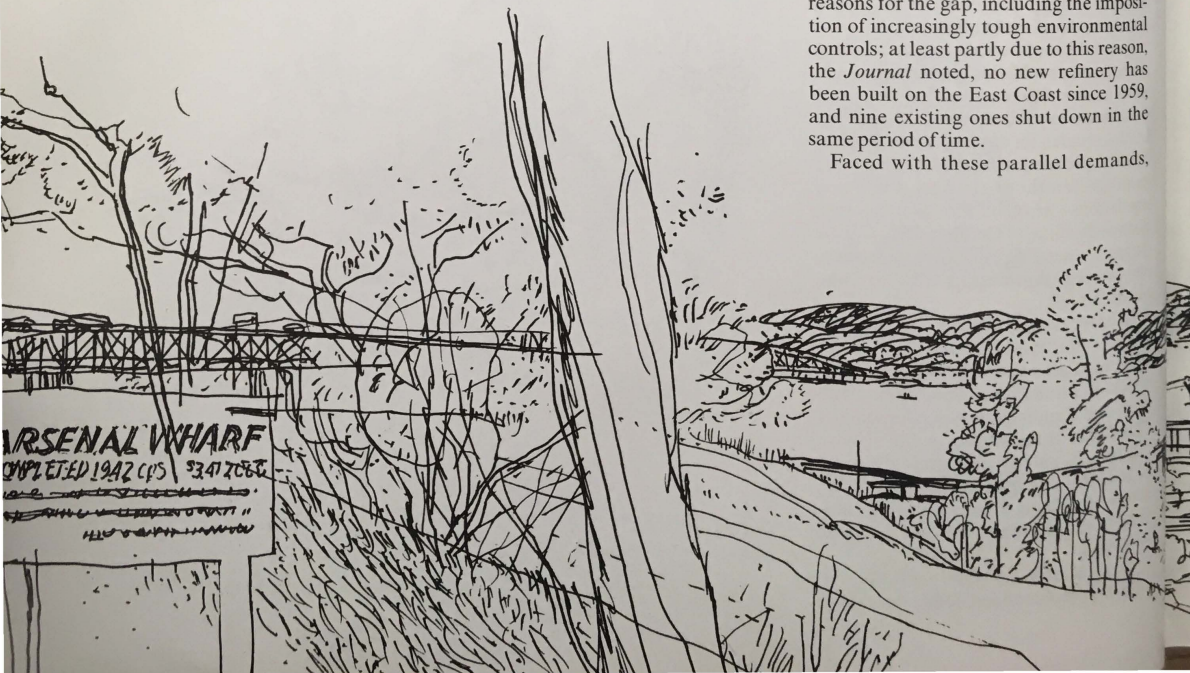
Dr. George E. Mitchell, air and water coordinator at Benicia, elaborates on the second point. "Each refinery must conduct its own program. Each must meet the technological demands not only of its location, but of the specific product it manufactures. This also applies to equipment required to reduce pollution."

An Exxon USA employee for 30 years and holder of a doctorate in chemical engineering, Dr. Mitchell notes that fighting pollution at Benicia runs up an operating bill of more than $5,000 every day. And he concludes:

"This sort of spending is not open-ended and it is not without some effect on the marketplace. Eventually it must show up in the price of products."

Running parallel to the demand for environmental vigilance by refineries like Benicia is the demand for the products they manufacture. In a nationwide survey of the industry in 1972, for instance, the *Wall Street Journal* noted that while American domestic refinery capacity increased 3 percent in 1971, this met only two-thirds of the rising demand for these products. The *Journal* cited a number of reasons for the gap, including the imposition of increasingly tough environmental controls; at least partly due to this reason, the *Journal* noted, no new refinery has been built on the East Coast since 1959, and nine existing ones shut down in the same period of time.

Faced with these parallel demands,



Benicia refinery employees nevertheless find time to contribute to the community. And much of the extracurricular activity concerns the environment.

Exxon USA, for instance, helped to form the San Francisco Bay Area Environmental Information Clearinghouse, an exciting new concept in drawing together ecologists, educators, and labor, government and industry leaders to solve mutual problems. Frank Chadwick is currently vice president of EIC. Exxon USA also contributes toward the agency's $51,000 annual budget.

The company is also a member of Clean Bay, Inc., formed in 1971 to provide a contingency plan for cleaning up marine oil spills should they occur. With impetus provided by the collision of two tankers in San Francisco Bay in 1971, six competitive oil companies, including Exxon USA, agreed to support the nonprofit agency financially and also to provide manpower.

Today, the partnership of Exxon USA and Benicia is working well. Although during the early days of operation, upsets or breakdowns caused smoke and noise and were a source of irritation to some people in the community, these incidents have diminished in number. Local authorities feel Benicia townspeople have accepted the refinery as a sincere industrial neighbor. Mayor Lemos cites the fact that Benicians enjoy a higher standard of living than they did a few years ago. While the refinery helped fill the job gap left by the arsenal's closing, its tax contribution to the city and schools of Benicia and to Solano County, and its addition to the tax base, also made possible a gradual reduction in Benicia's tax rate.

"Benicia enjoys many spinoff benefits from the refinery, too," Lemos adds. "For instance, our water supply was about a century behind the times. The refinery requires about three million gallons of water a day. So, we got together and talked about it. The result: a new water pipeline we can both use."

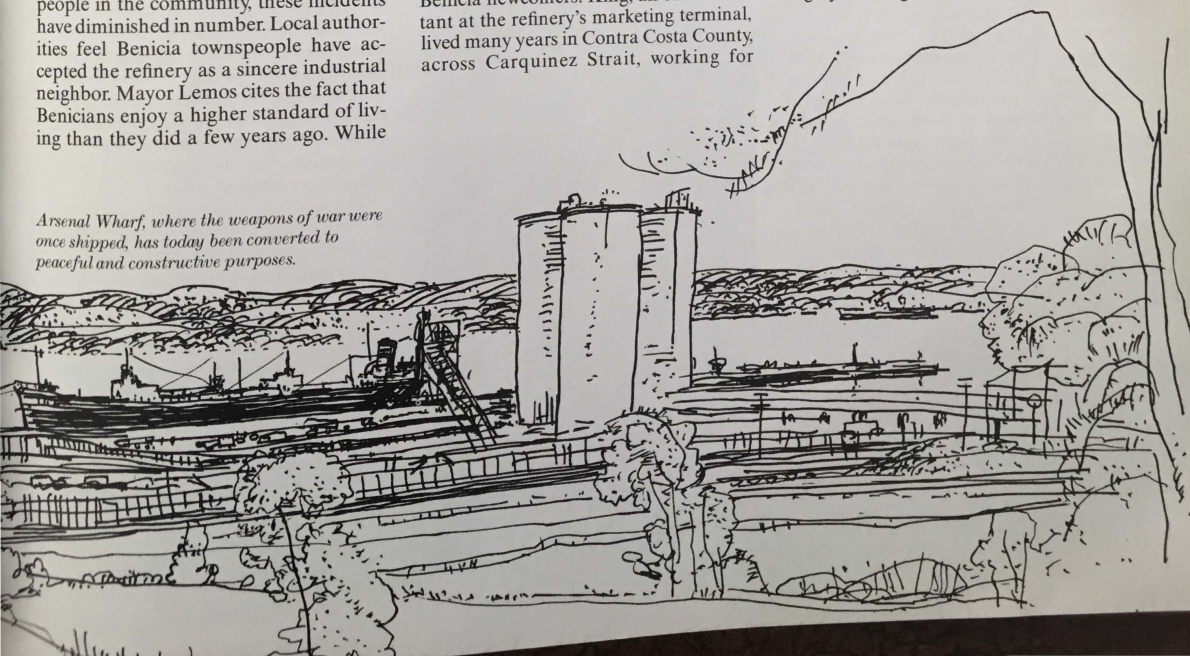
Pollution? Hear Nancy Mahoney, a Benician many years, now in charge of the refinery's central files. "Like a lot of people," she says, "I was concerned about the refinery. However, the benefits to our community in keeping property taxes down, providing employment and participating in activities of the community more than compensate for the minimal problems caused by the refinery. I should know—my home and property run right up to the refinery site."

William B. King and Steve Swenson, now Exxon USA employees, are both Benicia newcomers. King, an office assistant at the refinery's marketing terminal, lived many years in Contra Costa County, across Carquinez Strait, working for various oil companies. "The refinery at Benicia was a lucky break for me," he says. "It meant a good job, a move to Benicia—and cleaner air."

Swenson, a chemist in the refinery laboratory, migrated even further, from Anaheim in Southern California's Orange County. "I was tempted by an offer to work for Exxon USA," he says, "but I hesitated to make the move. For one thing, I'm an outdoorsman, an active member of the Sierra Club, and I was deeply involved in Southern California. Then, in Benicia, I happily discovered how much closer this town is to wilderness areas than are most in Southern California."

Perhaps the most convincing endorsement, though, comes from Garnard Ray, operator of one of Benicia's many antique shops, and a resident long before Exxon USA's arrival.

"I was dead set against a refinery in my town," says Ray. "I looked across the Strait where the other refineries are located and asked myself, 'Who needs another?' But I don't feel that way anymore. Whenever problems occur, we get together and look for solutions. Exxon USA has become a mighty fine neighbor." ■



Arsenal Wharf, where the weapons of war were once shipped, has today been converted to peaceful and constructive purposes.

A major refinery, a long pipeline or a huge marine tanker full of oil are obvious as potential risks to the natural environment and, because they are obvious, they tend to concentrate public attention on themselves. The safety of these major items of plant depends on a combination of technical expertise in design, construction and maintenance, and of the continuing care of those who operate them. Less in the public eye, but no less vital to the success of the oil industry in supplying the fuels and raw materials on which our economy depends, is the distribution system which handles oil products. In this article we look at the ways in which Exxon keeps that system safe in operation, and at how the technical and human factors are balanced in operation.

a habit of concern

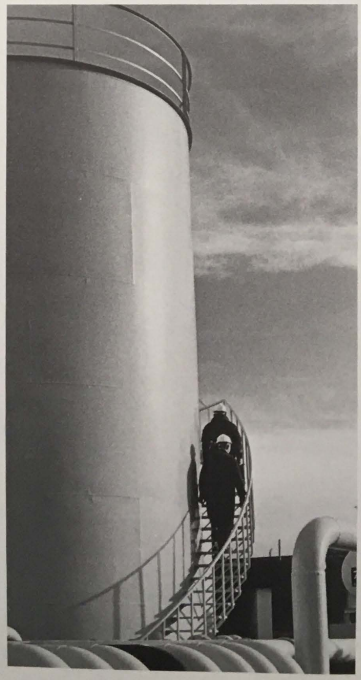
The oil which the tankers bring, and the refineries turn into useful products has to be distributed and sold before it is of any use. The system in which the products are handled is diffused right across the country and reaches out to its furthest corners. And the oil products which pass through these commercial veins and arteries can be potentially just as damaging to nature as the crude oil which comes to our ports. The cumulative effect of small unnoticed losses through defects in the distribution system could in the aggregate be just as damaging as the rare catastrophic accident to a tanker—more so, perhaps, as such losses would not attract the massive attention which a sudden disaster would.

The company has long recognized the need for the most careful control right down the line of our distribution system—control which is only partly a technical job and which for its success depends mainly on human care—that habit of concern which forms the title of this article. We also know as a company that the situation is not a static one. The degree and kind of precaution we have to take changes in time as technical possibilities improve and our own insights and public concern and involvement reveal more points we have to watch. Also not to be forgotten is that practices which were formerly acceptable become inadequate as the scale of oil-industry operations increases.

Following the flow of products from the refinery shows how we work now, and how the organization is equipped to identify new needs and change to meet them.

Very large customers for Exxon products—for fuel oil for instance, are served direct from the refinery by coastal tanker, by pipeline or by rail tank car. For the generality of sales, however, the first destination of the product is a bulk plant or terminal. These are assemblages of storage tanks and loading and unloading facilities which take in bulk-loads of fuels and lubricants and deliver them by road and rail vehicle in manageable quantities and in suitable packages to the enormous range of Exxon's customers. At one time there were hundreds of such plants, much smaller on average than the existing ones, and each serving an area defined by the working radius of a horse-drawn wagon. This total number has been reduced steadily with the advent of motor transport until now Exxon operates only thirty-six such plants to serve the whole of Britain supplemented by smaller depots operated by Authorized Distributors. This reduction in the number of plants is itself a benefit to the environment—though it carries with it the disadvantage that as the plants become larger they become more noticeable. The design of the plant has become more sophisticated though and advanced precautions can be incorporated into fewer, more efficient, plants.

The problem of siting such installations is that a bulk plant has to go where it suits Exxon's customers. Many, of course, are in areas already highly developed industrially but in serving farmers and other people in rural communities, particular problems arise, because of the need to



Where land is at a premium, (left) vertical tanks have to be used, but careful maintenance preserves a good appearance. An Exxon fleet of delivery tankers (top right) in their parking area—which has special drainage to prevent oil-loss into the ground water. Loading Exxon products (bottom right) by means of special articulated loading booms. The safety earth connection can be seen on the tanker on the right.

From quarterly publication, Exxon's affiliate in the United Kingdom, Summer 1972.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The SLURP oil skimmer, in use at a training exercise for emergencies, in co-operation with police and fire services.

preserve the beauty of the countryside. What we can do and are continually learning to do more effectively is to take advantage of natural contours of the sites we use to dispose the equipment most favourably and to use carefully designed paint schemes and screens of trees to diminish its visual impact. We realize that this amenity aspect should be considered as early as possible, in the process of design and plant development, if the optimum effect is to be achieved later in the life of an installation. The same methods can be applied with advantage in industrial areas, and Exxon is committing considerable funds to raising the standards at its older plants as well as improving the design of new.

The most prominent feature of a bulk plant is its tankage. Particularly in industrial areas where most of the plants are sited to be near customers, the pressures on land use make it difficult to build long low tanks and taller cylindrical tanks are the rule. These have, of course, to meet planning requirements and Exxon like other companies co-operates closely with the local authorities on painting schemes—there is a general swing away from the silver paint which was a visual cliché for petroleum plants a few years ago towards a more intelligent use of lighter colours. High maintenance standards are necessary if even the best-chosen paintwork is to keep decent in appearance and painting schedules are designed to suit the different locations—a seaside site needs repainting more often than a rural one for example. Tankage itself is not a serious environmental risk and devices such as the floating roofs on modern gasoline tanks can almost eliminate unpleasant odours. Over-filling of the tanks is a danger, but modern gauging and stock-control methods are devised to prevent it.

Products from the bulk tankage must be transferred to road or rail vehicles and must be metered and controlled on the way. The pipelines, valves and pumps which carry out this service are carefully designed and maintained to prevent leakage or mistakes which could cause loss of product. A prominent feature of bulk plants is the loading rack—the pumps, meters and loading nozzles which fill the road vehicles which deliver gasoline, fuel oil and other petroleum products.

These are being steadily improved with greater safety and more certain containment of the product in mind. Exxon is substituting pivoted arms for flexible hoses in the loading and unloading of road tankers and rail cars—they are less likely to leak or to be wrongly connected. Pre-set equipment is widely used—a fixed quantity of product is set on the pump-controller to match the empty space to be filled and the pump stops when that volume has been delivered. Additional safety against spillage is provided by the overfill protection devices fixed to the vehicles themselves and a system which prevents the product supply to a loading arm from flowing if the arm is not in the correct 'down' position for use. The old system of rail loading based on loading points spread down a length of rail siding has been replaced by a single-point arrangement in which tank cars are drawn one by one under a high-speed preset delivery head and loading takes place over a concrete pan fitted with special drainage and oil-interceptors.

The most serious ecological risk inherent in petroleum handling is that to water. Any loss or spillage remaining—after the evaporation which quickly removes much of the lighter fractions as vapour—in a plant will find its way, unless prevented, into the surface water. Exxon depots are fitted with internal drainage systems which collect all the surface water, minor spillages, drippings, etc. and pass the drainage through special oil interceptors before returning the water to the general drainage system.

There is, at the moment, no generally accepted standard for such effluents, or for methods of sampling and measuring

Special drainage ensures that the wash water from this vehicle-washing bay does not affect the oil-interceptors.

them. To enable us to decide on priorities for treatment a survey of actual water effluents from Exxon plants is underway and tests and research are in progress to find out what needs doing. A new company engineering standard for interceptors was recently introduced and research at our Abingdon Research Centre is directed at finding better ways of reaching a more stringent standard of cleanliness should that be necessary. The problems encountered in treating the surface water in Exxon plants are not due to oil alone. Detergents used in washing down road vehicles can spoil the action of oil-interceptors if they are allowed to get into the system and this can even result in the release of oil in the interceptor outflow. Special types of cleaner have to be used, or segregated drainage for the washing water which then, with the agreement of the local authority can go into the foul-water drains. A similar problem can arise in commercial car-washes, and Exxon is investigating the use of closed water-circuit washers in a pilot scheme. It should be said, however, that the effluent from our plants is probably cleaner than that which flows into the sewers from a rain-washed street as a result of crank-case drippings and loss from ordinary vehicles.

During transport in road or rail vehicles, the greatest ecological risk is, again, to water. If a rail car is derailed or a road tanker suffers an accident, the contents may be spilled—though good tank design can ensure that the spillage is limited. The Research Centre at Abingdon, Berkshire has designed a clean-up kit, incorporating oil-containing booms, a newly developed oil-skimmer pump, emergency storage for recovered oil and absorbents to clean-up the traces. The kit can be carried in an estate car, and each part is hand portable to an inaccessible spill. Strategically disposed throughout the distribution network, and backed up by training in their use, these kits will enable Exxon to tackle its own problems and to help other bodies or local authorities who have to handle oil-spill emergencies. Via the Institute of Petroleum, Exxon has co-operated with the Department of the Environment in formulating a plan by which an organizational network will be set up with River Authorities and other parties to ensure the prompt reporting and efficient mobilization of reserves to deal with spilt oil.

Major spillages are, fortunately, relatively rare, but there is a constant risk of minor oil losses when oil products are delivered to a customer's storage tank—if the tank is too full or the wrong tank selected, oil can be lost and may do damage. In this situation Exxon personnel must depend on instructions given by customers and the responsibility is divided. Only the greatest care in handling can protect against such losses and to ensure this care, Exxon has employed an ambitious safety incentive scheme called 'Safety and Me', or SAM for short, covering the mishaps which can occur on the distribution side of the business, and including spillages. The effectiveness can be seen in a 45 percent reduction in accidental spillages since 1969. We offer advice on storage and handling of oil to our customers, and are co-operating with other oil companies to produce codes of practice which will ensure greater safety at installations outside our direct control.

In tracking the flow of oil through the Exxon network it is obvious how many different jobs and people are involved in the safe handling of our products. Marketing Department has made generally available a little booklet which explains the companies' intentions in general and manuals of safe practices, training exercises for emergencies and incentive schemes are devised to bring home to each man and woman what *they* can do. And, in parallel with this activity proceeds the constant examination of our present ways and the search for solutions to our problems which will enable Exxon to further improve its performance in minimizing the damage to nature caused by the handling of oil products. ■

Singapore-bugging the pollution problem

Singaporeans—like many people—desire the best of two possible worlds: economic development and a clean environment. But, unlike many other areas, Singapore stands a good chance of achieving this balanced goal.

The large amount of industry drawn to the small country brings economic growth. But it also brings pollution.

Government and individuals working on environmental conservation in Singapore have an advantage, according to Mark Walker, Exxon's Singapore environmental coordinator. "They have a clean slate to begin with. Almost clean, that is. Air and water pollution to date in Singapore have been minimal."

Much has been accomplished to minimize pollution in Singapore and to keep it from growing. More important, however, is the fact that a plan to implement preventative measures, rather than curative solutions, has been developed.

Environmental optimism prevails in Singapore, according to Mr. Walker, and underlies the hard work that is in progress. With understanding among industry, the government antipollution unit and the Ministry for the Environment, Singapore should achieve its goal of economic development and a clean environment.

Exxon's Singapore affiliate has been concerned with environmental conservation for several years. Four months before startup of the company's refinery on Pulau Ayer Chawan, a team of environmental experts began a nine-month study of the air and water around the island.

Dr. K. K. Chin, dean of the engineering faculty at Singapore's Nanyang University, headed the study team which also included Dr. L. M. Gan, head of the chemistry department at the university, and Dr. K. N. Ong, head of the rubber and plastics division at Singapore Polytechnic.

The study team compared the data obtained before and after the refinery started up. It concluded that Exxon refinery operations had very little impact on environmental quality.

"The problem we face now," Mr. Walker said, "is the growing need for measuring environmental quality in an organized way to meet the potential hazards of air and water pollution. Cooperation is what it takes. Our policy is that industry should work together with government in developing programs aimed at diminishing pollution problems."

The government of Singapore has been actively engaged in environmental conservation since 1968 when the Environmental Public Health Act was passed. Since then, additional regulations and laws have been brought into effect to control pollution.

The Environmental Public Health Act and the Prohibition on Discharges of Trade Effluents into Water Courses, introduced in 1971, aim to control water pollution. While the latter affects water effluents from both marketing and refining installations, its prime impact relates to the pollution of fresh water. Rainfall is Singapore's major source of fresh water. A rising demand for fresh water, due to population growth and a higher standard of living, will necessitate using an ever-increasing percentage of the rainfall in Singapore. To do this, care must be taken not to pollute the rainwater.

Other legislation enacted in 1971 includes the Clean Air Act, which provides for controlling air pollution, and the Sea Pollution Act. The Sea Pollution Act and Port of Singapore regulations relate to shipping. Oil spill offenders are prosecuted under the Sea Pollution Act. The "polluter pays" principle included in this act allows the government to recover the cost of cleaning up an oil spill.

Since Singapore is an island nation with limited water resources, Exxon's Singapore affiliate has placed great emphasis on controlling water pollution.

In cooperation with the Port of Singapore Authority, the company returned the island of Sebarok to the government in January of this year. The Singapore affiliate and its predecessors had operated a bunkering terminal on the island for 54 years. Operations at the Sebarok terminal ceased in June, 1971, when new facilities at Pulau Ayer Chawan began handling all of the company's bunkering needs.

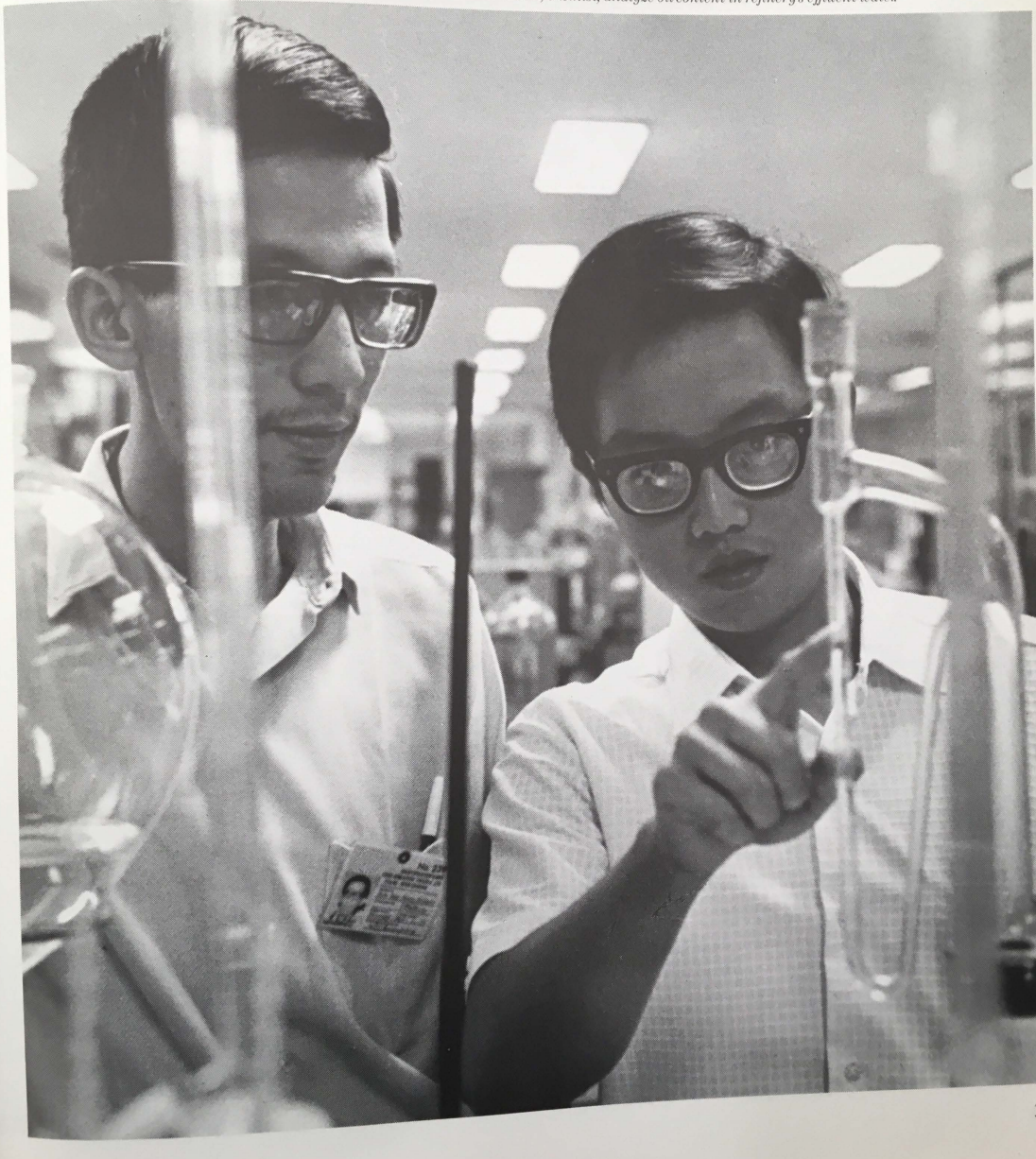
The Port of Singapore Authority plans to use the island for facilities to treat oily waste water. Ships calling at the busy port will be able to discharge their oily water from bilges, tank washings and ballast at the facility. The plant also will be used to treat oily wastes from onshore industries in Singapore.

Several facilities for controlling water pollution were installed in the Singapore refinery when it was constructed. Additional water treatment systems are being installed as part of the refinery expansion project currently underway.

Oily water from process units and water drawn off from oil storage tanks are treated in a separator. The oil is separated from the water, the oil going to a slop tank for reprocessing in the refinery. The water

From bimonthly publication, Exxon's Far Eastern affiliate, Number 1, 1973.

Low Hee Teck, environmental engineer, right, and Robert Goh, chemist, analyze oil content in refinery's effluent water.



Low Hee Teck with Mark Walker, right, environmental coordinator

from the separator is mixed with water discharged from the cooling tower and the flare seal drum. The three streams return to the sea at the same point.

The Singapore affiliate also has provided facilities to handle the oily ballast water from tankers calling at the refinery. Tankers pump their ballast to tanks where oil is removed from the water by gravitational settling. The recovered oil goes to the slop tank for processing in the refinery and the water is discharged to the sea.

The areas where the water returns to the sea is constantly monitored to make sure the treating facilities are doing their job.

The Phase II expansion project will add several sophisticated secondary water treatment systems to the Singapore refinery's water pollution control facilities.

One facility will be a "sour water stripper." The stripper will remove hydrogen sulfide from the water that comes from refinery process units. Once treated, the water will be discharged to the sea.

When one of the process units comes onstream in the expanded part of the refinery, it will produce water contaminated by phenol, a highly corrosive and toxic chemical in concentrated form.

The refinery found an "organic" answer to the problem. A certain strain of bacteria readily digests the undesirable phenol after it has been diluted. The bugs, as they are commonly called, produce harmless carbon dioxide and water in the process. The refinery plans to operate a special phenol lagoon in which colonies of the bacteria will eliminate this potential pollutant from all phenolic water before it is discharged.

The Singapore refinery and Exxon Research and Engineering Company in the United States, the major worldwide research organization of Exxon Corporation, collected and updated material gathered during the initial environmental study of the Pulau Ayer Chawan area. In addition, they defined the impact of the company's refining operations on the sea water surrounding the island.

These data were then used by Exxon Engineering to develop a complete contaminant balance. In developing the balance, potential polluting compounds in each refinery effluent stream were quantitatively determined. Engineers studied what impact the effluents from existing and possible new streams would have on the sea around Pulau Ayer Chawan. Based on these studies, the refinery could determine whether further water treatment might be necessary.

"Studies of this type are extremely important," Mr. Walker said. "It is only with this detailed analysis that we can identify the real problems and develop economical solutions to correct them."

In 1972, the company retained the services of a firm of consulting engineers to study service station effluents. The engineers recommended the most economical waste treatment facilities and developed operating and investment costs.

The study noted a two-faceted problem. First, some service stations are located in outlying areas that do not have proper sewage systems. Water discharges from such stations could pollute rainwater runoff. This conflicts with the need to use more of the rainfall and measures must be taken to prevent this type of pollution.

The second part of the problem concerns service stations that discharge their waste water into the public sewer system. This sewage is eventually treated in a unit called an activated sludge plant. This is another type of bug plant, similar to the system planned by the refinery to treat water contaminated with phenol.

In the sludge plant, bacteria eat much of the suspended organic matter in the sewage. However, the bugs are somewhat particular about their diet which must be carefully monitored and controlled. The bacterial colony could be damaged if certain types of pollutants got into the plant.

To meet this challenge, control must be exercised at service stations to be sure that substances potentially harmful to the bacterial colony at the activated sludge plant are not permitted to enter the public sewage system. The Singapore affiliate has submitted the study to the government, along with the company's view and commitments that resulted from the study.

Exxon believes that cooperation among companies is important in achieving solutions to environmental problems.

Inter-company cooperation began in Singapore about three years ago when a committee was formed to prepare plans for handling oil spills. The committee formed an industry cooperative which was recently brought under the leadership of the Port of Singapore Authority.

In 1971, the affiliate was instrumental in establishing an ad hoc committee primarily composed of representatives of refining functions in the Singapore area. Its purpose is to develop common goals related to problems of environmental conservation. Members exchange information on pollution control technology.

The first problem tackled involved the application of the Trade Effluent Law to refinery water effluents. The objective was to develop a consensus among members of the refining industry on effluent standards that would be appropriate for water discharged into the sea rather than into fresh water. Protection against pollution of fresh water was the basis for standards in the existing law.

In Singapore, cooperation in environmental conservation has gone beyond industry. The first step towards regional cooperation was taken in 1972, when the Science Council of Singapore and the U.S. National Academy of Sciences jointly sponsored a Water Workshop. Exxon representatives presented two papers at the workshop, which was attended by delegates from six Southeast Asian countries.

"Regional cooperation in adopting common environmental standards is probably going to develop, especially where countries are in close proximity like Singapore, Malaysia and Indonesia," Mr. Walker said. "However, before regional cooperation will work, each country must sort out its own environmental problems."

Singapore is trying to sort out its problems concerning environmental conservation, recognizing the potential danger industry poses to the environment. Singapore has the advantage of a relatively clean start and a strong commitment to protect the environment. The coral fish whose stripes of brilliant color beautify the waters around the islands of Singapore need not worry about the future of their marine home. ■

oil from the deep sea

Massive platform will be towed to production site, tilted upright by flooding buoyancy chambers in the legs, and secured to the ocean floor.

In the deepwater areas of the oceans, vast reserves of oil are waiting to be tapped. One such discovery has been announced—off the coast of California in the Santa Barbara Channel at water depths of 700 to 1,500 feet—by Exxon Company, U.S.A., Exxon's U.S. affiliate. The wells and offshore production facilities in this major new field will be in water two to four times as deep as any offshore tract now in production.

Deepwater production, as planned for the Santa Barbara Channel, will mark one more milestone in the oil industry's search for new sources of supply to meet the ever-increasing demand for energy. It will come none too soon as far as indigenous U.S. supplies of oil are concerned.

The actual technology to be used in operations in this area is not new but rather a practical extension of methods that have been used for many years to produce oil in shallow offshore waters. Harry Pistole, former production manager of Exxon USA's western division and now assistant to the president, explains: "The system we have developed includes few procedures or items of equipment that haven't been proved by long and rigorous use in offshore work. It is an evolutionary rather than a radically new approach. The underwater package is new, however, and we will use a step-by-step approach in our testing program. In our design work, we have made extensive use of the reliability techniques of the space industry."

The technology devised for production in the Santa Barbara Channel will unlock an important new source of energy. Offshore oil can be recovered safely and efficiently from unprecedented water depths.

The company's system for deepwater production has been in the making for more than eight years, but research and design work accelerated in early 1968 when the company paid $217 million to win outright or obtain a share of forty-seven federal tracts in the Santa Barbara Channel. Most of these are in water deeper than 600 feet, and several tracts are at depths of more than 1,200 feet. Since then, Exxon has drilled or is drilling twenty-eight exploratory wells in water depths ranging from 300 to 1,500 feet. Exxon has announced three significant finds of oil in the area explored to date. These have been made in the western end of the channel within a geological structure called the Five-Mile Trend, after its distance from the shore. Development plans call for the use of deepwater platforms supplemented by submerged production systems, which will enable some of the production equipment to be located at the bottom of the sea.

The technology may not be new, but the components in Exxon's system are im-

By Richard Rutter. The Lamp, *Fall 1971.*

pressive. Consider the first platform to be built. Initial plans call for a massive four-legged structure towering 775 feet, higher than a fifty-story building, as required for a water depth of 700 feet. Its weight is in excess of 20,000 tons. Up to sixty wells can be drilled directionally from its 150-foot square top deck. Each of the lower legs will be seventeen feet in diameter, and they will straddle more than an acre of the ocean floor. It will be by far the largest drilling platform in the history of the petroleum industry and will cost accordingly.

There is no yard on the West Coast capable of building such a giant structure. The probable solution will be to fabricate the platform on its side in a graving dock. After the platform has been constructed, the dock will be flooded to float the massive structure, which will then be towed to its proposed location twenty-five miles west of the city of Santa Barbara. Once it reaches the site, the platform will be tilted upright and lowered to the ocean floor by controlled flooding of compartmented buoyancy chambers in the legs. It will be set securely in place by steel piles driven deep into the channel bed through guide sleeves attached to the legs.

Drilling will be accomplished by rigs placed on the upper deck of the platform. On the slightly larger lower deck will be oil-handling equipment, gas compressors, generators, and the remote controls for a satellite submerged production system. The entire structure has been designed to absorb the pounding from giant storm waves. Since the site is close to the California shore, the platform has also been designed to withstand ground-shaking forces from a severe earthquake. The deepwater platform is similar to existing offshore structures, except in its unprecedented size and strength.

The submerged production system, or SPS, which will supplement platform development in the deeper water areas, is a practical application of the latest technology. Each such system will consist of as many as forty underwater wells completed in a cluster. The wells will be drilled directionally from a floating rig through the template structure of the SPS, secured to the ocean floor. When they are ready for production, the subsea wells will be connected to the SPS manifold, and the oil from them will then flow up through pipelines to the surface platform.

Plans for deepwater field call for platforms supplemented by submerged production systems.

The day-by-day operation of each SPS will involve modern technology, including electronics to monitor and "instruct" the unit, hydraulics to open and close valves, and safety devices that will automatically close off any part of the system that malfunctions. One unique feature will be the use of a special purpose manipulator. If,

Illustrations by Anatole Pasternak

for instance, a valve should need to be replaced, this device will be lowered from a work boat to the SPS where it will land on a track which completely encircles the unit. The manipulator moves itself around the track until it is in the right position to work on the part that needs replacing. It removes the defective part, inserts and tests the replacement, and then returns to the starting position to be hoisted to the surface. Television cameras and underwater lights on the manipulator enable an operator in the boat to follow the work below. The manipulator also includes a diving bell in which a technician can descend safely to the SPS on the ocean floor, to work manually when necessary.

Exxon USA considers the pollution controls built into each SPS unit to be of critical importance. An inverted drip pan designed to catch any leaking oil will cover the entire manifold section. If there should be a leak, the oil will flow from the drip pan into a sump and then up to the surface platform through a regular flow-line. Simultaneously, an electronic sensor will activate a safety device, closing down the wells and valves in that part of the manifold where the trouble lies.

A full-scale prototype of a three-well SPS is under construction at Ventura, California. It will undergo tests on land under atmospheric conditions and then be tested underwater in a concrete tank. After these tests, it is planned to attach the unit to the supporting structure of the first deepwater platform at a depth of about 200 feet. Three wells will be drilled, and the whole unit will be tested further.

All of the company's development plans are subject to government approval. The Department of the Interior has given permission for Exxon to act as the unit operator for all federal leases in the Five-Mile Trend, including those held by Standard Oil Company of California, and Shell Oil Company. One major advantage of a unitized operation is that it minimizes the number of wells and platforms required for full development of an area.

It is probably not generally realized that the Santa Barbara Channel has been the scene of offshore drilling since before the turn of this century. More than 200 wells have been drilled in the channel. In 1921 California became the first state to issue regulations governing offshore development. The first oil production from a platform in the channel began in 1958, and today there are some twenty oil and gas fields offshore—in waters under the jurisdiction of the state, within three miles of the coast. The deepwater production planned by Exxon will be in federal waters beyond the three-mile limit.

But before there could be deepwater production in the channel, there had to be exploration. Two floating drilling rigs were employed by Exxon, following the 1968 federal lease sale, to initiate the search for oil. These are the *Wodeco IV,* a ship-type vessel, and the *Bluewater II,* a semisubmersible platform—both equipped specifically for deepwater production. In order to keep the floating drilling rig, even though moored, closely aligned with a drill hole a thousand feet or more below on the ocean floor, engineers designed a special mooring system. Allowance had to be made for such natural forces as wind, currents, and waves as well as the roll, pitch, sway, and yaw that any craft experiences in open water.

Eight giant anchors, each weighing 20,000 pounds and nearly fifteen feet tall, were positioned around each drilling rig at a radius of almost a mile. Each anchor was linked to the vessel by chain and wire rope able to withstand a pull of more than 400,000 pounds. Acoustic signals fed into a shipboard computer showed the rig's position at all times relative to the hole being drilled. The mooring system proved to be so effective that the vertical alignment between the vessel and the drill hole never deviated by more than 3 percent of the water depth—well within the effective operating limit.

The most advanced safety devices have been used in the exploratory drilling. If unexpected high pressures are encountered in a well, blowout preventers located atop each wellhead can close off the space between the drill pipe and the casing in a matter of seconds, keeping the pressures under control.

Considering the great cost, why does the petroleum industry persist in its search in water depths never before developed? The industry has gone seaward because it had no choice.

Every day the United States consumes more than 550 million gallons of petroleum liquids and over 50 billion cubic feet of natural gas. Daily oil demand is expected to increase to more than 770 million gallons by 1980 and to more than 1.1 billion gallons by the year 2000. Natural gas demand is forecast at nearly 70 billion cubic feet by the end of the century. This means that, over the next three decades, the United States will require more than twice the petroleum and natural gas consumed during the entire 112 years since the birth of the oil industry in 1859.

Over the next three decades the United States will require more than twice the oil and natural gas consumed during the 112 years since the oil industry began in 1859.

Where is this prodigious amount of oil and gas to come from? Unless the United States is to become dependent on foreign sources, a large part of it must come from domestic sources. But oil and gas on land have become increasingly difficult to find. That leaves the offshore areas. Geologists estimate the recoverable reserves under the U.S. continental shelf may amount to more than 200 billion barrels of oil and more than 1,000 trillion cubic feet of gas.

The need is here. The technology is available. Engineers and certain specialists are confident that the deepwater reserves of the Santa Barbara Channel can be developed without damage to the natural environment. An important addition to the nation's energy supplies could be the result. ■

Submerged production system (SPS) will encompass cluster of wells drilled beyond lateral reach of surface platform but controlled from it

blowout school

Of the thousands of oil and gas wells that are drilled around the world each year, only a handful result in those violent eruptions called blowouts—but the possibility is still there.

Prevention is the most effective way to deal with the problem of blowouts, and to that end Exxon Company, U.S.A. established the world's first "blowout school." This unusual facility is centered around a mile-deep well on the vast King Ranch deep in the heart of south Texas. For the past three years drilling superintendents and contract crews from Exxon affiliates all over the world have attended annual sessions there to learn and practice the latest techniques in blowout prevention.

The practice well is the real thing. It has storage tanks, a pump, control manifold, a full array of pressure gauges and controls—all the diverse equipment that is used in the field to avert a threatened blowout. The training facility represents something of a paradox, set up mainly because there are so few blowouts. Many drillers get little actual experience with runaway wells, and the school thus gives them an opportunity to improve their skills in control and prevention.

It requires considerable skill when drilling a well to strike a delicate balance between man-made pressure and underground natural forces. At a depth of four miles, for instance, a drilling operation may run into temperatures of 500 degrees Fahrenheit and pressures of thousands of pounds per square inch. Under these conditions, one square foot of gas entering a well bore can suddenly expand a thousand times or more.

A sudden influx of fluids or gas into a well is known as a "kick." It is the driller's task to control the kick from far above on the rig. To lose control will result in the fluids or gas blowing out through the top of the well. The driller has only a few minutes to react to the increased pressure below and to take corrective steps.

The "students" at Exxon's blowout school get a course in reality when a 3,500-pound-per-square-inch kick is injected into the practice well. The first step is to stop drilling and shut in the well by means of valves. The driller then increases the flow of mud—a chemical fluid—down the hollow drill pipe. This exerts counter pressure at the bottom of the hole and keeps additional fluids or gas from entering. Balance is restored when the pressure in the well equals the pressure driving fluids or gas from an underground formation into the hole. The influx of invading forces subsides. Gas that has been expanding in the well is "bled" or led off through a special manifold connected to the well.

Exxon's blowout school was the only one of its kind until recently, when another major oil company built its own. Interest has grown. Currently, two others are being built—by a university and a group from the oil industry. ■

billion dollar brushpiles

Shortly after World War II, a charter boat skipper cautiously backed his sportfisherman between the guy wires of an umbrella-like structure which had just been built in the Gulf of Mexico. He showed the anglers aboard how to cast to the cobia which were enjoying the shade under this strange, new platform. In minutes, his wide-eyed customers were bat-

By Grits Gresham, Humble Way, *Third Quarter 1971.*

Fishing boats (below) leave Empire at dawn bound for the Gulf of Mexico. Skippers (right) set their course for any of 2,000 platforms.

tling fish and within an hour, had a boatload. It was the first tentative step into a phenomenon which revolutionized fishing in the Gulf, and boosted sports fishing into an industry of greater economic value and size than its commercial counterpart.

"It wasn't much of a platform," recalls that skipper, Captain Charles Sebastian, of Grand Isle, Louisiana. "It was really a test structure to determine the ability of the substrata to support weight. Just a large steel pipe sunk into the ocean floor with a small platform on top." But fish seemed attracted to it.

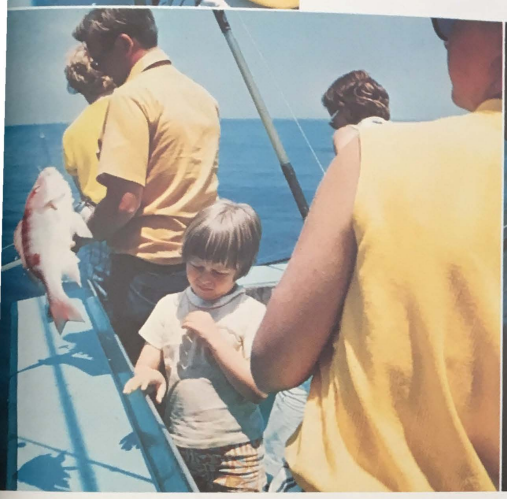
Later, in 1947, Exxon Company, U.S.A. built its multimillion-dollar "Grand Isle A" platform eight miles off the coast of Grand Isle. It was big, the first structure in the Gulf large enough to support a complete oil drilling rig and quarters for crewmen to run it. Even before it was completed in 40 feet of water, it had attracted swarms of fish, which in turn, attracted Sebastian and many other charter boat skippers. They found that fishing around the steel legs of the structure brought results. The word spread swiftly. "They're catching 'em around the rig." And a new, exciting, and amazingly productive pattern of saltwater fishing was born.

In the quarter-century since, oil companies have invested $7 billion offshore, and in the waters off the Louisiana coast, have installed some 2,000 platforms and structures to produce oil, gas, and sulfur. And anglers from throughout the nation are delighted, with good reason.

"Each of these platforms is like a brushpile in a lake," Captain Sebastian says, "except that they're made of steel. As soon as the underwater columns are in place they begin accumulating barnacles, moss, and other marine growths. These attract small fish. The big fish which feed on the little fish aren't far behind."

Of course Louisiana's offshore waters have long supported a prolific game fishery, and did so well before the advent of offshore oil drilling. But the presence of structures has eliminated much of the hard, time-consuming search for fish by creating an environment attractive to them. Elsewhere, natural reefs and shallow banks are favored by fishermen as gathering places for fish. But Louisiana's offshore waters are virtually devoid of natural reefs. Platforms, which one oilman describes as "the world's most expensive fishing lures," serve as artificial reefs. Some marine biologists believe the presence of platforms has increased the Gulf's fish population by enlarging their food supply. Others disagree, contending that not enough research has been done to be sure of this, and that the platforms serve as concentration points for existing fish. Nevertheless, biologists have found species of "tropical" fish around the platforms which previously had seldom been seen in the Gulf.

Fishermen don't care who's right. All they know is that they catch more fish than they ever did before. And do they catch 'em! Charter boats no longer report catches of individual fish; they list catches



Fishing the rigs (left), for red snapper, is fun for the whole family. Anglers (below), anchor between rig pilings to take sheepshead.

by the numbers of tubsful. Parties of four to 12 anglers often catch hundreds of red snapper, bluefish, dolphin, seatrout, Spanish mackerel, king mackerel, croaker and pompano.

Pompano! Louisiana offshore anglers seldom caught this epicurean delight in the years before the platforms were built. Now, catches of a hundred or more per boat are common during winter months. And a man catching pompano right and left hasn't time to wonder about the biological reasons for their being there.

Some charter skippers, such as Captain Louis Ramm, fish the rigs extensively. Much in demand and heavily booked, Captain Ramm operates his big, comfortable craft, *Early Bird,* out of Empire. He says he can't remember when his customers have failed to catch fish around the rigs. In his fast aluminum *Sea Hawk,* Captain Sebastian scouts the Gulf for billfish, amberjack, and wahoo, but he also fishes the rigs, especially when the action is slow in other waters.

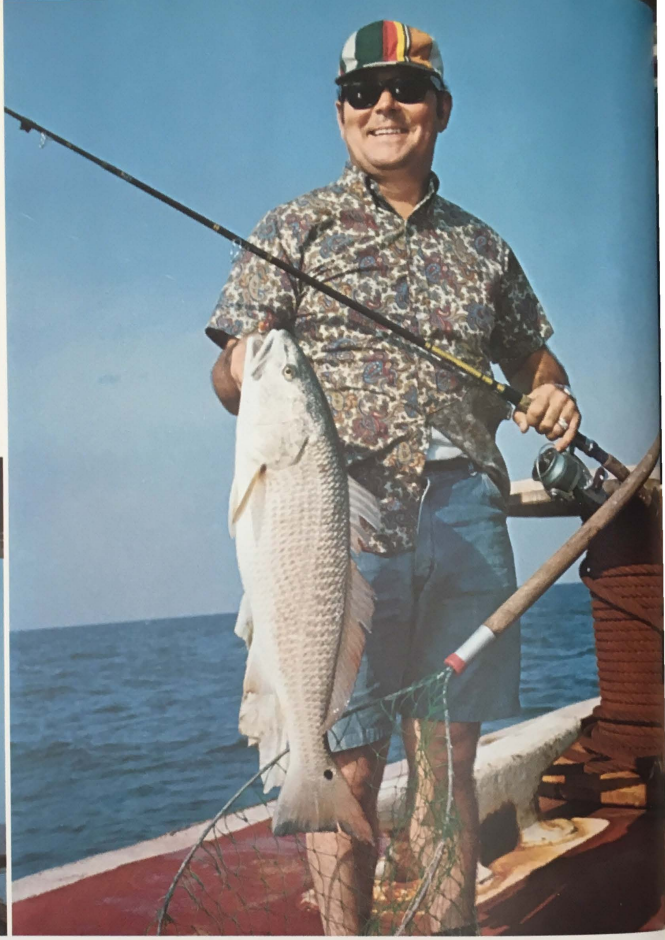
Not only charter boat fishermen work the platforms. The owners of private craft by the hundreds funnel into the Gulf from such jumpoff points as Shell Beach, Hopedale, Venice, Cocodrie, Leeville, Golden Meadow, Cypremort Point, and Grand Cheniere. Some prefer to stay in the quiet inner bays where platforms may be found in as little as ten feet of water. Others, possessing larger craft with greater range, may travel as far as 60 miles offshore to fish around rigs standing on a bottom that's 200 feet down. Prudent fishermen, though, resist the temptation to venture too far into the Gulf, despite the comforting presence of man-made structures. Experienced boaters know these offer little security when a sudden squall lashes calm waters into churning seas.

Before the advent of platforms, offshore fishing came to a standstill during the winter months. Now, anglers have learned that the period from November through March can be the most productive of all. Choosing a calm, cold day after the passage of a "norther," a wintertime fisherman can take as many as 21 different species of game fish, and his catch may easily run into three figures.

Night fishing, too, is now possible around some platforms where natural gas flares burn. The natural gas is produced along with oil, but at some locations in amounts too small to be worth the cost of bringing it to market. Rather than have the gas released into the air, where an explosion might result, the appropriate state or federal authority instructs that it be disposed of by controlled burning. The flame attracts fish in great numbers and results can be spectacular.

Whether the cause is man-made, or is the result of seasonal weather patterns, or is a natural cycle in the biological history of various fish species, it is a statistical fact that the size, composition, and abundance of catches in the Gulf fishery are undergoing changes. Last winter the king mackerel run was the best and the longest in history. But for pompano, it was a dud.

Bluefish (below), provide great winter sport for rig fishermen. Redfish, or channel bass (right), are among 21 varieties taken near the rigs.



Ordinarily, the time schedule for various species runs like this:

As spring brings warmer weather, jack crevalle lead the parade of summer species, appearing on the scene about the first of May. Tarpon and cobia arrive around the middle of the month, followed in a couple of weeks by dolphin. King mackerel make their debut in June. They will remain through the hot months.

As cold weather approaches, these species will disappear to be replaced by the winter contingent: red snapper, silver trout, sheepshead, croaker, and pompano. They'll stay until April.

Bluefish and bonito may be taken throughout the year, although they are usually more abundant during winter months. Spanish mackerel are year-round residents also, providing superb sport on light tackle.

But sometimes, for reasons of its own, a species may ignore the schedules. Last fall, the big king mackerels appeared to miss their bus, and happy sportsmen made great catches of kings weighing from 25 to 50 pounds throughout the winter. Not until April 23 did they suddenly vanish.

If you'd like to fish the rigs in your own boat, you'll find most oil companies cooperative. They ask only that you observe two rules: Don't interfere with the workboats and crewboats which ply between the platforms and shore bases; and don't climb or sit on the platforms.

Or, if you prefer, contact one of the charter boats at Grand Isle or Empire. Daily rates vary from about $150 to $300, depending on the boat, the number of fishermen it can carry, and the distance you expect to go offshore. Holiday and weekend rates are slightly higher than weekday rates.

Most charter boats are certified by the Coast Guard for six fishermen, but Sebastian may take 15 and Ramm is authorized for 20. Your individual share of the cost should work out to around $25 or $30.

Some charter boats furnish rods and reels at no charge. Others rent equipment at $2.50 to $3 an outfit. You'll probably enjoy fishing with your own gear, especially if you are a light tackle buff. The same freshwater tackle you use for bass will work just fine, but take the precaution of loading your reel with 20-pound-test monofilament line.

You'll find Grand Isle at the south end of Louisiana Highway 1. It's an eight-mile-long barrier island connected to the mainland by a bridge. It has adequate motel and restaurant facilities. There is a sod strip for light aircraft near the bridge on the mainland, but you'll have to make arrangements for transportation to the Isle if you come in by air. Larger private aircraft can be accommodated at the Houma airport, 70 miles from Grand Isle, where you can rent a car.

Empire is 60 miles south of New Orleans via Louisiana Highway 23. It, too, has adequate overnight and restaurant accommodations, but your best bet may be to rent a car in New Orleans and drive down there.

Members of a charter party divide their catch of pompano and red snapper. Sunset finds happy sportsmen (below), homeward bound.

The usual charter boat day begins at 6 in the morning and ends around mid-afternoon. Longer trips may be arranged, and flare fishing is a nighttime pursuit.

How to dress? In the summer, wear a long-sleeved shirt, dark glasses, and a hat. Be sure to bring suntan lotion. The reflection of a bright sun off the water can inflict a severe burn. In winter you'll want to start the trip with plenty of warm clothing, but expect to peel off a few layers as the sun gets up.

Will you need a license? Yes. Louisiana requires a license for both fresh and saltwater fishing. If you're a resident of the state, it will cost you $2; out-of-state visitors can buy a license good for one week for $3 or for the entire year for $6.

How do you fish the rigs? For red snapper, croaker, grouper, and other bottom feeders, fish near the bottom with a weighted hook baited with shrimp or cut bait. Try light tackle and lures for bluefish, mackerel, pompano, or spadefish. Blues and Spanish mackerel will hit almost anything that wiggles through the water, but the best bet for pompano is a jig tipped with a small piece of shrimp. Spadefish, too, take shrimp readily.

To catch king mackerel, jack crevalle, and cobia, try this popular and effective technique: Bait an unweighted hook with a small live fish, such as a croaker or hardtail. Let the Gulf current carry your bait under the platform. You'll get arm-wrenching strikes, often near the surface. But this sure-fire method can also produce an encounter with some of the Gulf's more alarming denizens as well. You may find yourself hooked to a tarpon, shark, jewfish, or even a billfish. Unless you are equipped for such large game, the encounter will be brief. For example, sea bass as large as 700 pounds have been taken from beneath some of the platforms. Near rigs in deeper water, anglers have caught blue marlin weighing over 600 pounds and a bluefin tuna was taken that tipped the scales at 895 pounds. So, be prepared for anything.

Trolling around the platforms is popular, too. This method is especially effective for bluefish, tarpon, and dolphin.

And if you try flare fishing, the trick is to anchor just outside the circle of light and to cast lures into the lighted area. It's light tackle fishing at its best, with bluefish and spotted seatrout providing most of the action. What kind of lures? Just about any freshwater bass lure will do, although spoons or jigs are most popular. For extra fun, give topwater plugs a try. The fish prowl near the water's surface and will smash a floating lure with gusto.

Spearfishermen, too, find the platforms productive, although not without some hazards. After shooting a giant fish, a skin diver may find himself pulled with express-train speed through the barnacle-encrusted pilings of the fish's home.

A piscatory potpourri. That's what these billion-dollar brushpiles provide. The oil companies may not have intended it that way, but that's how it's worked out. And why not enjoy it? ■

hilda's hidden haven

Go with Hillary Hauser and Bob Evans on a fascinating underwater excursion to the depths below an oil production platform situated in the Santa Barbara Channel.

Hilda is a large, grey lady whose concrete and steel legs stand firmly on the bottom of the Pacific Ocean. Her home is about two miles out to sea in the Santa Barbara Channel, in 106 feet of water. Here, Hilda works as an oil production platform, producing oil and gas from the Summerland field for Exxon Company, U.S.A. and Standard Oil Company of California. She's been on the job for 15 years, and has never missed a day's work.

Of course, Hilda doesn't get around much. She never goes visiting. But as photographer Bob Evans and I discovered, she never lacks for company. Hilda's protective bulk and her structural underpinnings house an unseen world of marine life as rich in numbers and variety as any tropical reef. Descending in scuba gear into Hilda's waters we found ourselves completely taken with the sea creatures living there in happy harmony with their environment. In spite of her remoteness, Hilda is hostess to a bewildering variety of house guests.

Among her constant companions were barnacles, which clustered in dense colonies along her underwater surfaces. We watched one perform a fan dance. A red, feather-like feeler would twist out of the small opening at the top of its tiny, volcano-shaped shell. It would wave its fan, combing the water for food. At the base of the feeler was an orange, eye-like orifice into which it would tuck diatoms snagged by its tentacles. It was a lively act, and I was amazed at how different this animal seemed from the motionless barnacles I had so often seen in tidepools.

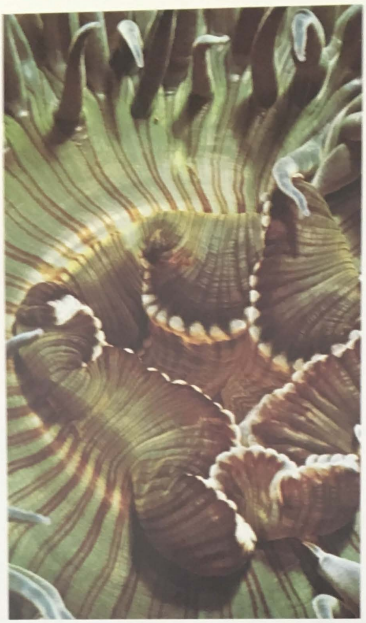
In company with the barnacles, mussels clustered in vigorous colonies on Hilda's legs. Every beachcomber has seen mussels, but few have seen them in action as we did. As Bob was preparing to photograph the familiar black mollusk, a member of the colony released a stream of milk fluid that spread quickly among the other shellfish. It was the first step in mussel reproduction. These animals release sperm and eggs directly into the water where the two unite. The fertilized egg settles to the bottom, or substrate, where it begins the business of growing a shell. We were actually witnessing life in the making! But Hilda had other surprises in store for us.

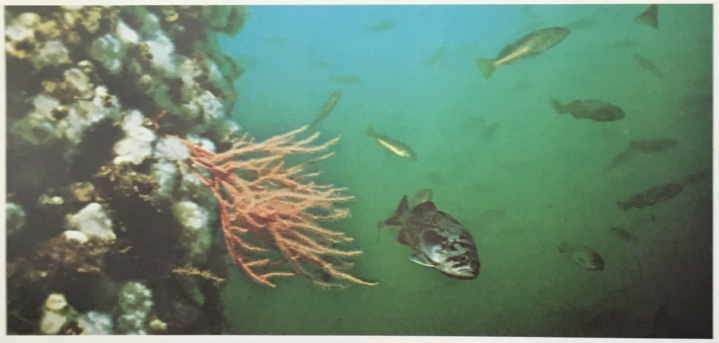
As we descended further along the legs, I thought about the diversity of life that had become dependent upon Hilda's presence. This sort of thing is not normally associated with oil production or offshore drilling; yet, here, beneath an oil production platform, was a hidden haven for plants and animals. In all my years of diving in Southern California waters, I had never seen such a concentration of fishes. There were thousands! The sea perches were the most numerous—white sea perch, black sea perch, rubberlip sea perch, pile perch—all were there. They swam in and out of Hilda's stanchions and cross-members, nibbling on mussels, scallops, and hydrozoans. Rockfish were right behind the perches in numbers, but they stayed closer to the substrate. Spiny, frog-like sculpins sat motionless on the outgrowths of shells and soft corals. When we came too near, they darted for cover. Huge sea bass and calico bass cruised lazily around Hilda's sheltering legs, eyeing us carefully, but they were not too worried about our presence. Here, a juvenile cabezon hid against a starfish as we swam by. There, a huge treefish remained motionless in the angle of two crossmembers, zipping away as we approached. And there were more —many species that we couldn't even identify.

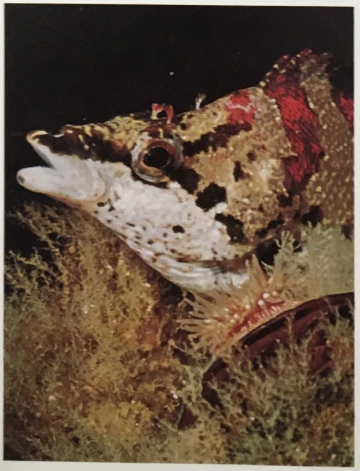
We found that the most life was in the 30 to 40-foot depth. Within this range the

Resting on one of Hilda's cross-members, Hillary Hauser watches swarms of fish attracted to this artificial reef. (Below), author Hauser peers into the inner workings of a transparent comb jelly.

By Hillary Hauser; Illustrations by Bob Evans, Exxon USA, *Fourth Quarter 1974.*







One of the many varieties of anemones, this specimen was photographed at a depth of 40 feet. A sea fan (center) reaches out to sift food from the current, as scores of rockfish swim by. A convict fish, (bottom) so named because of his stripes, rests among mussels and soft corals.

anemones, starfish, sponges, and soft corals seemed to concentrate, and these were outnumbered only by the barnacles and mussels. Most of the fish grazed here, too. Away from the platform, schools of pelagic mackerel swam in coordinated unison, imparting a sense of terrific activity to the motionless structure.

Altogether, Hilda was one bustling community! On every surface life blossomed. We could not put our hands anywhere on the pilings or stanchions without squashing a living, breathing thing. The huge concentrations of club anemones astounded us. These animals had grown and spread over almost every inch of surface not occupied by the mollusks. They bedecked Hilda in a riotous rainbow of reds, oranges, pinks, and magentas. Here and there, big colonies of white anemones protruded from pilings on their elongated columns, punctuating the underseascape. The fact that Hilda was in the oil business didn't seem to bother the animals in the least. Indeed, without Hilda they wouldn't have been there at all.

It has been observed that any foreign object placed in the sea will attract marine life and that fish and invertebrates immediately colonize anything that offers shelter or a surface to cling to. Divers have known that open ocean bottoms are veritable subsea deserts devoid of fish. But the presence of any object—a sunken ship, a wrecked airplane—immediately attracts life. Subsea plant life begins to grow immediately on the foreign objects, and the little organisms that require protection or a solid surface on which to attach themselves quickly colonize the spot. They are followed by larger creatures that feed upon the existing life. Finally, the predatory pelagic fishes come around to prey upon the smaller animals.

In recent decades, this knowledge stimulated a flurry of artificial reef building. In 1958, a biologist with the California Department of Fish and Game began building reefs in the Pacific Ocean, using a variety of bulky objects: worn-out streetcars, junked automobiles, quarry rocks, and concrete "fish apartments." He found that all the objects attracted fish and developed into bustling reef communities. In 1960, Floridians built a reef out of junked cars and 5,000 old rubber tires that were placed on the

ocean floor five miles off the Northeast Florida shore. The reef still provides good fishing, even though metallic objects have long since deteriorated. In 1961, the Tidewater Artificial Reef Development Association sank a load of car bodies in 15 feet of water in Chesapeake Bay. Where before the area had been almost devoid of life, it was soon swarming with flounder, sea bass, blennies, hogfish, sheepshead, chubs, and other species.

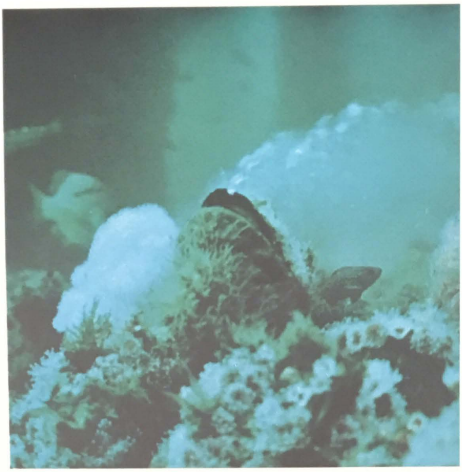
Offshore oil platforms function as artificial reefs, as fishermen well know. In the Gulf of Mexico, commercial fishermen and charterboat operators visit the numerous platforms as the best guarantee of a catch.

Skeptics have decried artificial reef building as nothing but a license to dump trash in the ocean. But the fact remains that fish need a haven in order to thrive, and that whole new communities of fish and invertebrates spring up whenever the proper shelter is provided.

Platform Hilda is a good example. Little life could be found in her open ocean environment before she was set in position in 1959. Yet in her first month a Department of Fish and Game study found that hydrozoans had already begun to grow. In the second month, schools of sardines, mackerel, and bonito had moved in. Simultaneously kelp scallops, barnacles, and mussels began scrambling for space on the pilings. Not long after, nudibranchs were depositing their egg masses by the thousands and establishing their dense, phosphorescent colonies.

Where do they come from? How do sessile creatures—those that attach themselves permanently to some surface—find their way to Hilda? As Shane Anderson of Western Marine Lab in Santa Barbara points out, "The rig is in deep water and pretty far from any established communities of marine life. It is unlikely that any organism crawled across the bottom and up the piling." Anderson speculates that most, perhaps all, sessile organisms arrive as larval forms, drifting in upper water layers of ocean currents amid plankton. Once contacting the piling surfaces, the larvae establish themselves and begin to grow into their mature forms. It is not a matter of simply moving a viable marine population from one spot to another. Lar-

Surrounded by strawberry anemones, a barnacle waves its fan-like feelers.



A mussel releases a cloud of seed in the first step of mollusk reproduction. Graceful, flower-like nudibranchs by the thousands (center) have colonized the pilings of Platform Hilda. In kaleidoscopic colors (at bottom) sea urchins, mussels, and club anemones cluster on a pipe.

val forms drifting in the ocean will die eventually if they cannot attach themselves to a solid substrate where they can grow. For them, Hilda's presence, along with her cousins in the channel, Hope, Heidi, and Hazel, means life itself. The recent demise of Harry, another Santa Barbara cousin removed by his owners from the channel when his wells could no longer pay the rent, left homeless countless organisms.

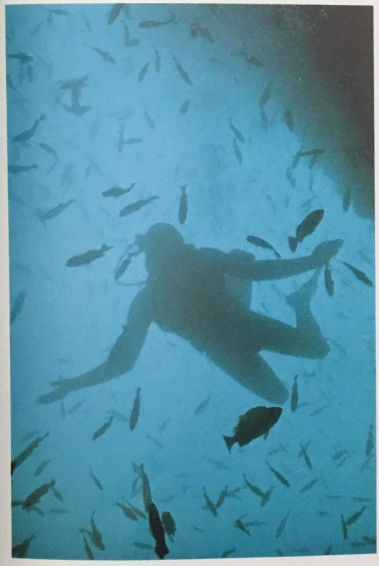
As I continued to explore Hilda's watery haven, Bob was focusing on some strawberry anemones which bloomed in vibrant red patches everywhere on the pilings. About 10 feet away five giant ocean sunfish (mola molas) were hanging suspended in liquid space, their big eyes watching every move I made. These pelagic fish are disc-shaped, looking as if they had been born without tails. "Mola" means millwheel, and the fish was obviously named for its resemblance to a circular millstone. Mola molas are frequently seen by boaters in the Santa Barbara Channel as they sun themselves on the surface. But often all a boater can see of the mola mola is the sudden splash it makes when it dives for safety. It isn't often that a human gets a chance to see one of these fish underwater. They are shy and flee at the slightest hint of danger.

I waved frantically at Bob, and when I had his attention, I turned and began swimming toward the strange fishes. They didn't move. I held my breath so that the noisy bubbles from the regulator would not scare them, and was soon in their midst. I extended my hand to one, and was totally surprised when it moved toward me. I stroked its side, which it seemed to enjoy. For a full minute, we played a massaging game. For me, it was man and wild animal establishing communication on a fundamental level.

The mola molas drifted off, and Bob and I turned back to the platform structure. We saw a giant jellyfish, gracefully but ineffectively propelling itself through the water by contracting and relaxing its huge bell. Suspended in the water close to the jellyfish was a comb jelly, a seemingly fragile blob so transparent that you can see its inner organs working away inside. I

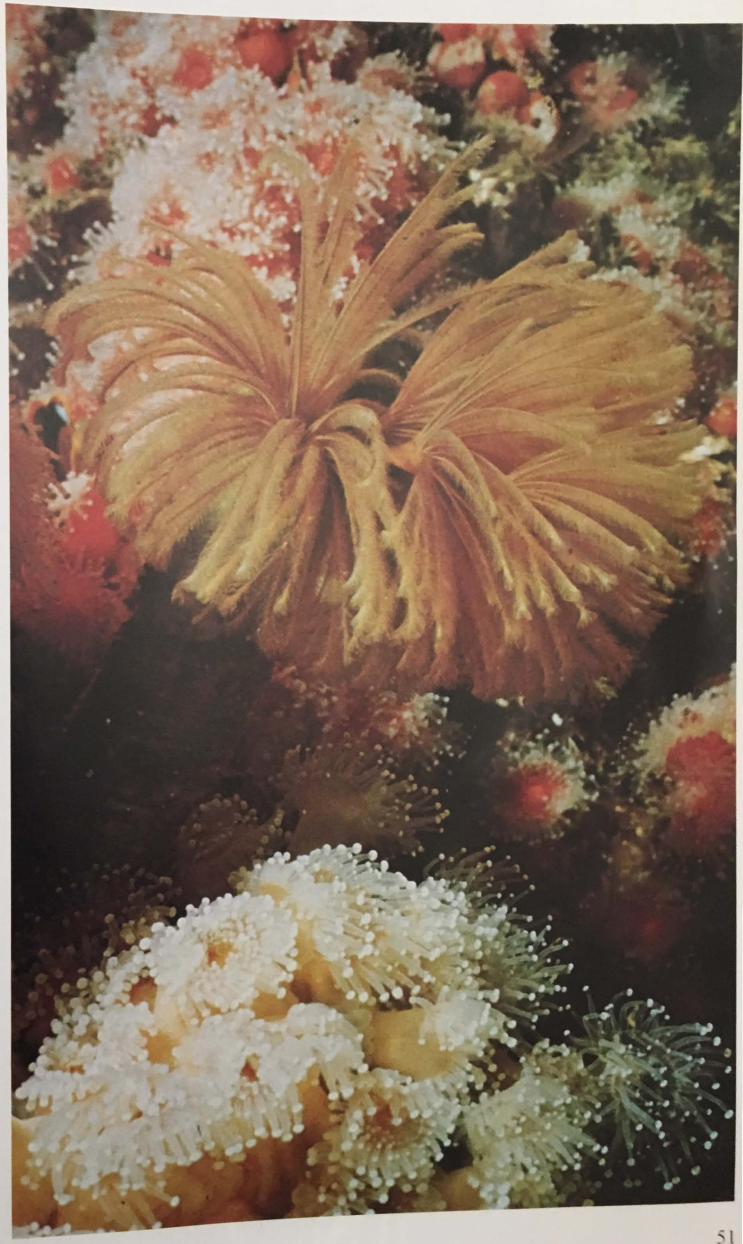
At left, perch, rockfish, and other varieties throng beneath Hilda's protective structure. A feather-duster worm (below) spreads its plumes amid a colony of strawberry anemones.

poked around at this strange creature a bit, investigated its interior machinery, and turned to find Bob. He was homing in on something and I swam in closer to see what it was. Before us was the largest gathering of nudibranchs either one of us had ever seen. These tiny, flower-like animals are well known to California divers for their graceful, undulating movements. They



come in many colors of such intensity that they seem to glow in the dark. The nudibranchs we were looking at had white bodies, their gills trimmed in iridescent blue and gold. They were bright, beautiful subjects for Bob's camera.

As we boarded our boat and headed back to Santa Barbara, Bob and I reflected on the things we had seen and the excitement we had felt beneath platform Hilda. We looked behind us at this solid, steel lady who hummed with activity—machines churning above the water, fish scurrying about below. I thought about the mola mola that had become my friend, and of Hilda herself. Indeed, she was a living example of a harmonious partnership between industry and nature. ■



Seawater cascades from the Kobe's *hold as the dry-docked ship is made ready for repairs. Exposed is the 32-foot gash in the bottom.*

Nobody even felt it when the Kobe touched bottom at Mont Louis, Que., but she suffered a gash 32 feet long in one of her oil-filled tanks. Here is what happened afterwards.

grounded!

A small cargo ship, the *Monica L.*, was at the jetty at Mont Louis, Que., just before 11 a.m. Oct. 30, 1970, when an Exxon tanker, the *Kobe* hove in sight. It was a beautiful Friday, visibility was good and when Capt. S. de Felice of the *Kobe* sounded his deep whistle, small boys on bicycles darted along the main street of Mont Louis to see 'le grand bateau.'

The *Kobe* isn't very big as tankers go—21,000 tons, loaded with 133,335 barrels of bunker fuel for Gaspé Copper Mines, Ltd. For several hours it had been anchored out in the Gulf of St. Lawrence waiting for the high tide that would allow it to clear the bottom of the dredged channel.

Now the pilot had come aboard to help with the landing. When he left the jetty it was empty, waiting for the *Kobe*, and the *Monica L.* was tied up at another quay. In the interval, the smaller ship had moved to the main jetty, right where the tanker was scheduled to tie up. The *Monica L.* was loading lumber from a stake-bodied truck, and three more loaded trucks were parked along the jetty, blocking the 300-ton ship from the view of the tanker.

Neither Capt. de Felice nor the pilot could see the *Monica L.* until the *Kobe* was only 150 yards away from it. He blew several blasts on the *Kobe's* whistle, warning the *Monica L.* to leave the dock and get out of the way. He swung the wheel hard to the right, letting go the anchor on that side at the same time. His action averted a collision but it also took the *Kobe* out of the dredged ships' channel and into a shoal area. She hit bottom, ripping a 32-foot gash from two to 12 inches wide in her hull along the bottom of No. 1 tank, one of the 15 compartments in the ship. But so smooth was the grounding that nobody on board heard or felt a thing.

On hand to witness the docking and unloading of the *Kobe* was Capt. John A. Hunt. He is one of Imperial's six pollution control inspectors—five retired tanker captains and one chief engineer—hired back by the company to be present whenever product is being unloaded or loaded into charter ships. They make sure that anti-pollution measures are observed and start emergency action if necessary.

Capt. Hunt embodies Imperial's belief that prevention of accidents is a more promising way of avoiding oil pollution than clean-up afterwards. The company's attitude is that spills result from errors of procedure or deficiencies in equipment, and therefore they can be prevented. This belief has been translated into a number of policies and practices, among them a navigation policy stressing that speed and economy come second to safety, and requiring ships' officers to work from voyage plans prepared and documented in advance—rather like the flight plans filed for aircraft. Masters and chief mates of very large tankers in the Exxon fleet also receive training in the handling of their vessels by operating carefully-scaled models as big as 40 feet long on a lake at Grenoble, France, and in a simulator at Delft, Holland, that duplicates the kind of training pilots of aircraft receive.

The navigators of tankers today are taking another leaf from the book of aircraft

By Fergus Cronin, Illustrations by John Mardon, Imperial Oil Review, *Number 3, 1972.*

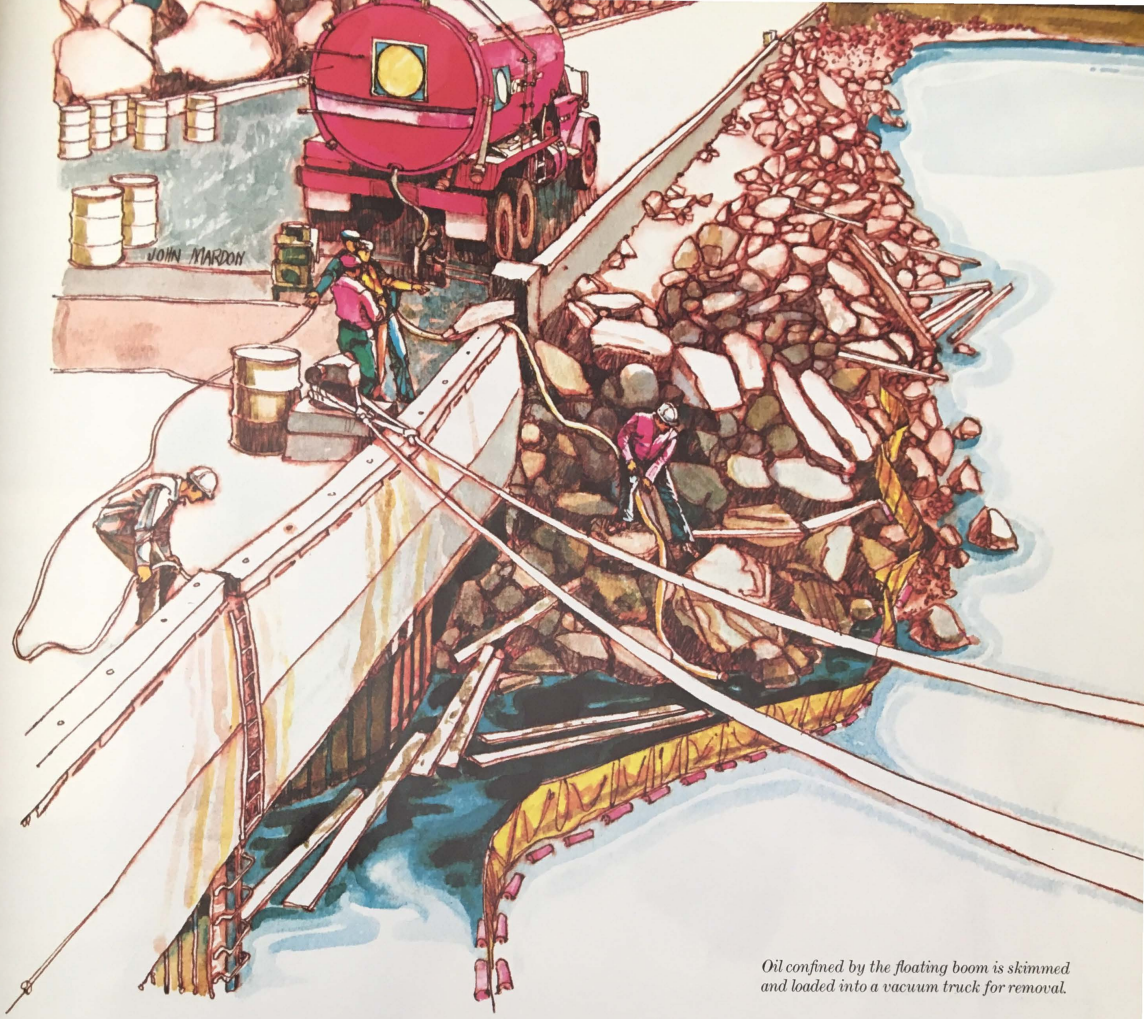
Deck pumps emptied the damaged tank from the top to let water flow in through the gash, sealing the hole.

experience. Aircraft cannot yet be made strong enough to withstand crashes and still get up in the air; consequently, aircraft are equipped with devices to avoid accidents. The lumbering tanker is in a somewhat similar position; its size and inertia make it slow to respond—a 250,000 ton tanker has 140 times the momentum of a Boeing 707—and despite its steel hull it is no match for the unimaginable power of rocks and sea. Here, too, the sensible course seems to be to avoid collisions and a number of guidance systems are under consideration. Some of them plot the courses of other ships in crowded channels, others attempt to spy out underwater obstacles; all show promise, although some of the more sophisticated devices suffer from a kind of electronic sea-sickness. The vibration and salty humidity of life at sea makes them unreliable, at least so far. Yet work on a reliable system goes steadily forward, for methods that will prevent accidents are of much greater value than cleaning up after a spill.

But while improved procedures can reduce the incidence of accidents virtually to zero, the possibility still exists and the damage to the *Kobe* was an example.

Capt. Hunt had seen the near-collision but neither he nor anyone else knew that the *Kobe*'s hull had been holed, in part because water flowed up through the hole and prevented the oil from escaping.

The *Kobe* began discharging the cargo at 1:40 p.m., pumping out her tanks one by



Oil confined by the floating boom is skimmed and loaded into a vacuum truck for removal.

one. It was not until about 6 p.m. that No. 1 tank was reached. As the pumps began to work there, they agitated the contents at the bottom of the compartment and oil and water began escaping from the gash. At the same time a sample showed there was water in the tank and unloading was shut down immediately. And several things began to happen all at once.

The *Kobe*'s captain put in a call to her owners' representative, Exxon International in New York; Capt. Hunt called Imperial's marine management in Toronto; the department of transport was alerted; planes were prepared at New York and Toronto to speed experts to the scene; a gang of Mont Louis men was organized and work was started on a wooden plank boom to try to contain the oil and prevent its spread along the shores. A diver was summoned from Rimouski; a flexible boom—1,100 feet of 43-inch deep, tough plastic-coated nylon fabric, so constructed that it could float vertically, partly in, partly out of the water—was ordered from Montreal; a rush call was made for a vacuum truck to suck up the oil.

By 8 a.m. Saturday the boom, the vacuum truck, oil-dispersing compounds and two pumps were on their way to the scene and at least 10 people were converging on the Gaspé by plane, car and truck from Toronto, Montreal, Quebec, Rimouski, Gaspé and New York.

Robert Fern, Imperial's assistant coordinator of environmental protection, was one of those called from Imperial's head office in Toronto. He arrived with several others by air about 5:30 p.m. on Saturday. From the plane he could see the plank boom in place, stretching from the bow of the *Kobe* to a rocky point a short distance away, and holding most of the oil in a small area in front of the ship. But the tide and the waves had bent the boom in places, and a faint slick of oil was escaping the boom and drifting towards the east shore of the harbor. The flexible boom was already being installed, a job that took most of the night, illuminated by floodlights and a generator loaned by Gaspé Copper Mines, Ltd. It took 11 men until 3:30 a.m. before Fern could record in his carefully kept log: "Ship completely encircled." About 6 a.m. dawn broke. Fern examined the area and found that about half a mile of the shingled shoreline had been lightly

The nylon boom goes into place. It floats upright in the water, confining any surface oil.

contaminated with oil. Six tractor-trailer loads of peat moss were ordered from a plant near Rimouski.

Sunday afternoon Bernard Brouillet of Imperial's public affairs department in Montreal called on the mayor of Mont Louis, Jean Louis Lapointe, as well as the parish priest, Father Richard, and conducted them on a tour of the tanker and what was being done about it. The mayor was quoted the next day in the area's newspaper *Le Voyageur de la Gaspésie* as saying: "The company has done its civic duty by making available in Mont Louis all possible measures which will clean the pollution from the town's beaches." Representatives of the ministry of transport and the department of public works inspected the operation and, satisfied, left it in Imperial's hands. In fact, when the clean-up was finished, people in Mont Louis said the shore never looked better—the crews picked up all the trash and litter as they went along.

For the next few days a team of men that numbered 30 at its peak, most of them hired in Mont Louis, worked at spreading and collecting the peat moss, tending the floating booms and other chores. The *Kobe*, which normally would have gone within 24 hours of her arrival, had to wait four days while the oil was removed from the damaged tank. It was not until 4 p.m. Wednesday that she sailed, heading for drydock and proper repairs.

Before Fern left on Nov. 3—a day before the *Kobe*—he recorded: "South shore clean except for minor spots on rocks... gulls in area are clean ... offshore wind (and) faint sheen of oil passing by stern of *Kobe* ..." cleanup of small patches of oil went on for another week under the direction of L. J. Orr, environmental coordinator of Imperial's refinery in Montreal East.

It was estimated that from 100 to 200

barrels of oil had escaped. At $3 a barrel, the lost oil was worth only a few hundred dollars—but the entire clean-up operation, including the hiring of men and equipment, transportation and accommodation, cost more than $86,000.

The spill at Mont Louis went relatively unpublicized for two reasons: it was a small spill, and the equipment and techniques to cope with it were quickly available. Because of two previous accidents involving oil-carrying ships, something had been learned about coping with marine oil spills.

The first was the wreck of the *Torrey Canyon* in March, 1967, off the southwest coast of England. She was carrying 119,000 tons of Persian Gulf crude oil, and the consequent fouling of English beaches warned the world of the growing danger of pollution from accidents involving tankers; growing if only because every year more oil is moving to meet energy needs of the world. Ships are bigger, too, but all of the new supertankers carry equipment that makes them safer to operate. The chances of a supertanker having an accident are extremely small.

In 1969 Imperial created a special environmental protection department; among its responsibilities is the coordination of anti-pollution efforts that date back to the 1930s. The department faced its first major test four months later when the ill-fated *Arrow* was wrecked in Nova Scotia's Chedabucto Bay in February, 1970. It was Imperial's first experience with a major spill at sea.

"What we learned from the *Arrow*," says Harvey Clare, Imperial's coordinator of environmental protection, "is that no matter how much effort you put into prevention—and we do our best to avoid accidents—you must be prepared in case you should have a spill. You've got to be able to

With the oil confined by the boom, the Kobe *turns to sluicing down its anchor chains.*

respond fast and effectively. To do that you need a good organization."

It was this organization that helped with the *Kobe*. "It's very much like fire prevention," says Clare. "You have to act fast, you have to have the equipment at hand to fight the problem, and you have to have people handy who know how."

By the time of the *Kobe* affair, the company had already organized its facilities across Canada into eight regions with an oil spill committee in each. The organization was deliberately decentralized so that authority and know-how would be closer to any emergency. The Mont Louis episode was directed by Jack Carbert, the Quebec region distribution manager for Imperial's transportation department, and he was one of the first Imperial people on the scene.

Research may solve the problems of the increasing contamination of the world's waters, and Imperial has become heavily involved in research on an industry basis. Although the *Kobe* spill was not considered a major one, its cost in effort and money to prevent contamination of the environment emphasizes how troublesome spills are, and how hard to cope with. But research is going on in many areas to find more efficient equipment and techniques of handling any spills in the future.

One study supported by Imperial is being carried out on lobsters in St. Andrews, N.B., by scientists from the University of Guelph who are studying the long-range effects of oil on marine life. Imperial has also co-operated with the department of Indian affairs and northern development, the University of Ottawa, and several university scientists in a number of projects attempting to learn the probable effect of an oil spill in the Arctic.

Some studies have come up with various apparent ways for handling oil spills, but there have always been drawbacks. A number of researchers have developed strains of bacteria that gobble up some fractions of spilled oil in laboratory experiments. But there is concern about possible side effects from the bacteria. "The practical value of these new bacteria is as yet an unknown quantity," says Fern.

Another imaginative technique tried at the scene of the *Arrow* sinking was scattering millions of tiny porous glass beads over the slick. The "Sea Beads" became coated with oil, which was then set afire. The beads made it possible to burn off some oil that was so mixed with water it could not otherwise be ignited.

The use of dispersing agents that will not be harmful to fish is a field of intense interest. "Slick-lickers" that suck oil off water have been used in quiet waters.

The "sand sink" method of handling spilled oil has been proposed. It involves treating sand with a chemical that makes oil cling to the individual grains. The sand is sprayed on a slick and sinks to the bottom, taking the oil with it. The obvious disadvantage is the fact that the oil-sand mixture might smother bottom-living forms of life.

There is no pat solution for oil spills, says Imperial's Harvey Clare. Each occasion requires different kinds of solutions, depending on the size of the spill, the circumstances that caused it (grounding, storm, collision, etc.), proximity to shore, water temperature, size of waves and strength of wind.

"The sad truth," adds Bob Fern, "is that we haven't yet found a simple or easy way to handle oil spills. As with the *Kobe*, it's still a matter of using booms, skimmers, suction devices and peat moss or other absorbent material, a laborious, time-consuming and costly technique which makes us more than ever concerned with prevention, as well as cure."

Consequently, one of the decisions made in the wake of the *Kobe* spill was to provide each region in Canada with self-contained emergency vans equipped with the basic equipment likely to be needed to clean up a spill. The equipment will include not only hard-to-get items like rubber suits, walkie-talkies and a loud-hailer, but everyday items like shovels, rubber boots, flashlights, rope, jackknives, pliers, wire and pitchforks covered with screening for picking up oil-soaked peat moss. The equipment will be packaged so that it can be shipped quickly by air. A basic kit of this composition contains equipment worth about $3,000, but with specialized oil spill equipment like emergency lighting, booms, skimmers and pumps, the cost can reach $30,000.

"The whole idea behind the contingency package," Fern explains, "is the fact that a spill may take place on a Sunday at 2 a.m. when no hardware store can be found open. We must avoid a case of losing a battle for want of a horseshoe nail." ■

new boom sweeps clean

When Reese Norton heard of the great oil blowout of 1969, he couldn't believe it at first. He drove 80 miles from his office in Inglewood to Santa Barbara, parked on Plaza del Mar, and walked down to the beach. Then, he believed…

What a *mess,* Norton thought. Chocolate-colored crude oil covered the waters of the picturesque marina, staining everything it touched: pleasure craft, breakwater, sandy shore. Emergency crews scattered straw to absorb the oil. Scores of newsmen reported gruesome details to a worldwide audience.

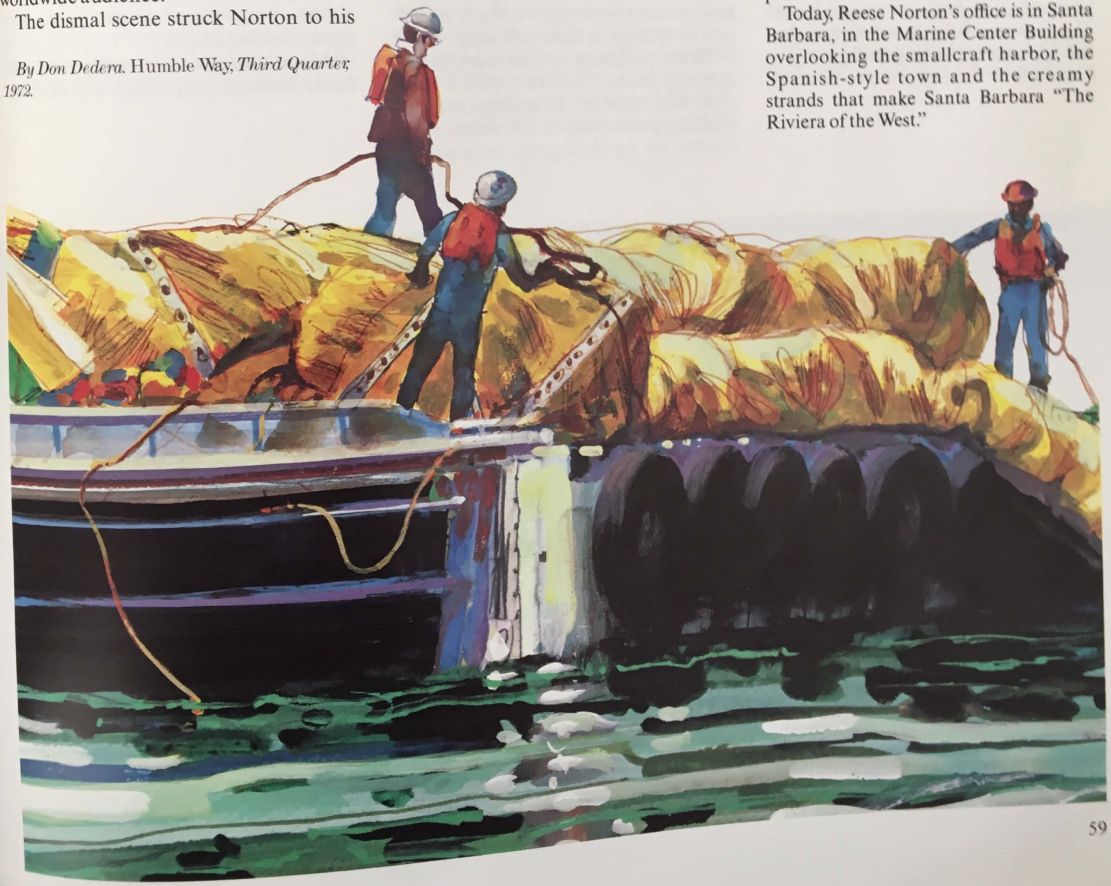
The dismal scene struck Norton to his soul. His life was oil. He was born in a tiny cottage on a hill above a California refinery. His father, and his grandfather before him, were oilmen. For 37 adult years, Norton had explored for oil, found it, and produced it—in pride. In the company where he worked as a field supervisor, he became recognized as a fighter against pollution, and an expert in drawing up contingency plans for coping with accidents. When the oil industry banded together to curtail spillage into Los Angeles' Ballona Creek, Norton took the lead, knocked heads together, and insisted that every spill, however minor, in every tiny tributary, be identified and corrected.

Now *this,* at Santa Barbara.

"I remember saying to myself at the time, 'It shouldn't happen, and if by some freak circumstance it happens, there should be some way to contain it and pick it up before it comes ashore, and God forbid, if it threatens a coast, we should have better defense weapons than straw and pitchforks.' "

Today, Reese Norton's office is in Santa Barbara, in the Marine Center Building overlooking the smallcraft harbor, the Spanish-style town and the creamy strands that make Santa Barbara "The Riviera of the West."

By Don Dedera. Humble Way, *Third Quarter, 1972.*



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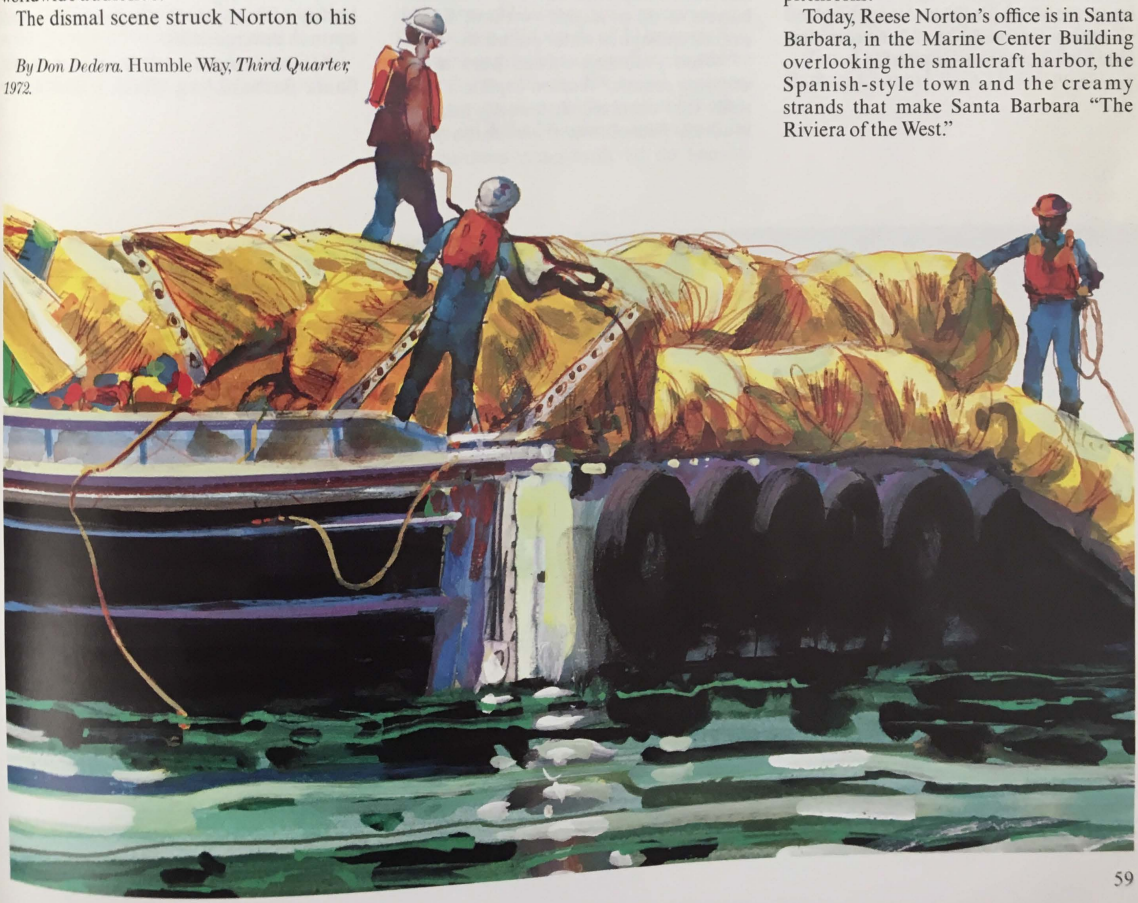


Immaculate sloops and cabin cruisers bob at every slip, sandpipers pursue morsels along the whispering surf, commercial fishermen unload their channel catches upon the mollusk-encrusted wharf, volleyball addicts joust on sandy shoreside courts, bikini beauties laze at Los Baños del Mar, and tourists from Iowa cast for corbina in the combers where Cabrillo landed in 1542.

"Santa Barbara's environment is back to normal," Norton says. "My job, plain and simple, is to help keep it that way."

Norton is executive vice president of Clean Seas, Inc., an independent, nonprofit firm founded and supported by 15 major oil companies, Exxon Company, U.S.A. among them, operating along the south central coast of California. The exclusive role of Clean Seas is to provide a capability for quickly containing and cleaning up oil spills, regardless of source, along 250 miles of coast from Point Dume on the south to Cape San Martin on the north. In Clean Seas' region of responsibility are 16 oil platforms or islands, and 12 tanker terminals, as well as considerable transient tanker ship traffic.

Two years after formation, Clean Seas comprises a reaction force of proven brainpower and formidable equipment. In Clean Seas' arsenal is a boom that can capture and hold oil in the open sea, in strong currents, high winds and heavy seas. In effect, Clean Seas is maturing as the oil-spill equivalent of a fire department, with Norton as the fulltime chief.

"Clean Seas is the expert specialist in its field," Norton says. "We can quickly bring together all the skills, manpower and equipment available anywhere in our area. This amounts to a massive capability—far greater than any single company could muster in a time of trouble."

Before the dark days of winter 1969, Norton believes, the oil industry was lulled by its own record—in nearly 70 years of drilling in California waters, there had not been an offshore oil well blowout of any consequence. To that time, 500 exploratory holes had been drilled from fixed or floating structures, 443 offshore oil wells had been completed, and over 1.3 billion barrels of oil produced—without significant oil spillage or water pollution.

"What problems existed were in the shipping centers," Norton explains. "The spills that occurred in loading and offloading petroleum from ships were cleaned up by third-party contractors."

Norton points out that in places such as San Diego, San Francisco, and Los Angeles, various contractors developed considerable know-how in dealing with minor spills in sheltered waters.

"But after Santa Barbara," Norton says, "our pledge was to combat spills offshore, if need be, out in the channel wide open to the elements—and that was a whole new ball game."

To brainstorm answers, Norton recruited some of the brightest minds of the California oil industry. Organized into task force teams, they have developed the means for:

> Maintaining a detailed and current inventory of every piece of cleanup and containment available. This includes gear of the oil industry, independent contractors, and government agencies.

> Encouraging development and production of new and more effective equipment and methods, where technology appears to lag behind potential threats.

> Determining the need for and availability of manpower which can be called upon in emergencies.

> Maintaining a command post on the Santa Barbara jetty which is completely

equipped with the most modern of radio communications and banks of telephones.

Most important, keeping an up-to-date and comprehensive contingency plan for coping with spills or blowouts, large or small.

"We can't wait for an alarm, and then all of a sudden start scrambling for help," Norton says. He wants Clean Seas prepared for any important eventuality, including the staging and deployment of equipment, wildlife rescue, procurement of supplies, feeding and housing of workers, transportation needs, and aerial surveillance of a spill. "Name it and we've got it in our contingency plan," Norton says. He observes that Clean Seas can be called into action by anyone that needs help—a member company, a nonmember company, or a government agency.

Clean Seas' budget is shared by member companies in proportion to their offshore activities. Most of the money goes for equipment or supplies, and to perfect more effective ways of combatting spills.

In improving their ability to combat spills, Norton encountered a troublesome problem early in the organization's life: the lack of a really good boom which would contain oil where there was noticeable current or wave action. "People have made booms out of everything you can think of," Norton says: logs and chains, aluminum and canvas, plywood and oil drums. But they all had one shortcoming. They wouldn't do the job we wanted done. Where there was current, the boom would tilt, allowing oil to flow underneath; and when there were waves, oil would splash over the boom and escape. And battered by wind and waves of moderate severity, a boom might disintegrate.

It fell to a task force of engineers of Exxon USA, and its affiliate, Exxon Production Research Company, to create an oceangoing boom of unprecedented strength and effectiveness. And this they proceeded to do.

The goals of the task force were ambitious: they wanted a boom that would survive 20-foot waves, two-knot currents, and 60-knot winds. These values were drawn from studies that showed that the Santa Barbara Channel, 99 percent of the time, had waves of 12 feet or less, currents of one knot or less, and winds of 40 knots or less.

Another goal was a system that could be loaded onto trucks for rapid highway transportation, could be assembled readily by unskilled workers, and could be launched swiftly from either ship or shore.

Working to these specifications, the task force devised what they called the Bottom Tension (B-T) Boom.

Essentially, the B-T Boom is a semi-submerged barrier formed by a tough, flexible laminated belting eight feet wide, similar to those used ashore for conveyor systems carrying gravel or ore. This is suspended from polyethylene buoyancy units four feet in diameter and 13 feet long. The units are joined by a lattice of stout polypropylene rope, and at the bottom of this net, the wrist-thick steel tow cable is attached. It all fastens together with common nuts and bolts.

Says Jerry Cunningham, one of the Exxon engineers, "The weight of the heavy tow line at the bottom of the curtain keeps it under tension and upright." Thus, the name: Bottom Tension Boom.

In tests, untrained workmen assembled the boom from the deck of a workboat in six hours. On the beach, they did it in less than five hours, and launched it through four-to-six-foot surf with breakers rising occasionally to eight feet.

Towed to natural oil seeps in the Santa Barbara Channel, the B-T Boom prototype

surrounded and held slicks in waves six to eight feet high, with a 1¼-knot current and 20 knot winds. Later, the boom was recovered without damage through the surf.

Reese Norton and Clean Seas were convinced. The first 500 feet of B-T Boom went to Clean Seas, and an order was placed for 500 feet more. Moreover, the San Francisco counterpart of Clean Seas, Clean Bay, Inc., wants 1,000 feet, too.

Nor is the B-T Boom the only weapon in Clean Seas' arsenal. A lightweight, high-volume skimmer system sucks up the oil caught by the B-T Boom. Additionally, Clean Seas has perfected an Oil Recovery System consisting of a skimmer boat and towed booms. The system can clear a swath 200 feet wide through waves as high as three or four feet. On call by Clean Seas for use in calm waters are a score of skimmers and four miles of light booms.

"And we have on standby," Norton says, "all of the smaller equipment that eventually cleaned up Santa Barbara in 1969." Looking for increased oil activity in the channel, Norton believes he should have at least 3,000 feet of B-T Boom ready for deployment in the area.

Norton is first to agree with critics who say that Clean Seas is like a fire department that has never fought a fire. Thus far, Clean Seas has not been called out to sweep up a spill.

Norton, of course, hopes the emergency never arises. "But that doesn't mean we are unproven," he insists. "Our training programs have been extensive, and our capabilities have increased tremendously over what was on hand three years ago."

Qualified approval of the progress of Clean Seas and similar organizations comes from officials most interested in protecting California's sea coast.

In a speech in May, 1972, at Santa Barbara, Dr. Vincent E. McKelvey, director of the U.S. Geological Survey, called Clean Seas a commendable example in a nationwide network of organizations whose sole purpose is containment and elimination of oil spills.

Santa Barbara Harbormaster Don Sathre was on duty during the 1969 spill. Says Sathre, "Clean Seas is certainly a step in the right direction. Of course, there hasn't been a crisis since Clean Seas was founded, and it remains to be seen how Clean Seas can perform in an actual emergency."

But the harbormaster, who has known frustration, says he feels a lot better knowing that one phone call will bring ou Clean Seas and all its resources. "I've bee in almost daily contact with Clean Sea personnel," he says, "and the oil industr picked the best man possible to head u the program. I have unlimited faith in th integrity of Reese Norton."

Captain W. H. Putman, of the California Department of Fish and Game, long ha crusaded for strict environmental safe-guards. In a recent speech in San Diego he said, "The state wholeheartedly approves of the objectives of the oil industry's cooperatives and nonprofit corporations formed to combat oil spills."

Elbert Wilkinson of Los Angeles, offshore operations engineer with the California Division of Oil and Gas, offers these evaluations of Clean Seas:

"As the state regulatory agency, we've been in close touch with Clean Seas from the outset. It's remarkable enough to have 15 highly competitive companies agree on anything. Yet that's what has come about, and a lot of progress has been made.

"It seems logical and proper to me that the industry should provide this capability for containment and cleanup. Here, ready

"I think of Clean Bay as my auxiliary, and vice versa," says Norton. Mutual assistance agreements involving Clean Seas and Clean Bay with other cleanup organizations multiply the available response from Mexico to Canada.

There's one question Norton hears every day, yet he still pauses reflectively before answering. His mind goes back to 1969 to the most disheartening day of his career, when he walked along East Beach at Santa Barbara and watched a brown curl stain mile upon mile of *La Tierra Adorada*, the beloved land.

Could Clean Seas today handle the oil produced by the Santa Barbara blowout? Norton answers:

"You must bear in mind, that was a tremendous volume of oil released at a rapid rate during a 'hundred-year storm' of a severity not likely to repeat more than once a century. I doubt that any effort by man could have had much effect offshore during that storm.

"But given less severe weather and seas, and a few thousand feet of the 21st Boom, yes, I feel certain we could have been quite effective in containing that oil." ■

the cleanest industrial port in america

A lot of oil moves into and out of American ports every day, right? Right!

And where you've got oil, you've got pollution, right? No! Not necessarily.

Oil shipments and pollution don't go hand in hand, as nearly 100 American ports are proving. How? By forming cooperatives which serve, much like volunteer fire departments, to combat oil spills and prevent pollution of port waters.

Do they really work?

Well, take Corpus Christi for example. This Texas city of 204,000 is a major port, ninth largest in the U.S. in volume. And the petroleum industry is the port's heaviest user. The chamber of commerce reckons that of Corpus Christi's manufacturing gross ($280 million annually) and shipping tonnage (30 million tons) 80 percent is oil-related. Each year, some 300 million barrels of crude oil and oil products traverse the port's waters.

Furthermore, Corpus Christi's city limits enclose several oil and gas fields, with 200 wells in the bay and 400 on land. Gas reserves in the bay are estimated at 3 trillion cubic feet and valued at $912 million. Which, as Mayor Sizemore observed, "is no small increment in our economy."

And what has this done to the marine environment of this Texas city?

Says Commander M. H. "Mike" Eaton, "Corpus Christi is probably the cleanest industrial port in America." The captain of the port and the Coast Guard's chief pollution control officer for the Coastal Bend of Texas, Commander Eaton points to a spirit of community cooperation and concern in Corpus Christi as the key to the port's cleanliness. "My counterparts in other ports are frankly envious when I describe the broad-based pollution control programs in action down here," he says.

His views are seconded by Jerry Thornhill, chief of the Emergency Response Branch, Region II, Environmental Protection Agency. "The Corpus Christi experience proves dramatically that industry, government, and a concerned public can work together harmoniously to achieve a clean environment," he says. "Wherever ecologists meet," he adds, "the Corpus Christi story should be told."

Perhaps it's the location which inspires those who live and work in Corpus Christi to be especially concerned with the quality of the city's environment.

A split-level, high-rise downtown rises on the shores of Corpus Christi bay which was first discovered by Spanish explorer Alonzo Alvarez de Pineda in 1519. Resort hotels look down on palm-shaded beaches and marinas filled with pleasure craft. Miles of stately dwellings line Ocean Drive, termed by one travel writer as "America's loveliest residential drive."

Across a causeway is Padre Island, a mile-wide sliver of beaches and sand dunes stretching virtually untrammeled for 110 miles along the South Texas coast. Within it is the 80-mile-long Padre Island National Seashore, which hosts more than a million visitors a year. They come to swim, surf, fish, sunbathe, birdwatch, shellhunt, and sightsee, and in the process, help to make tourism Corpus Christi's second largest industry. Last year, tourists pumped $161 million into Corpus Christi's economy.

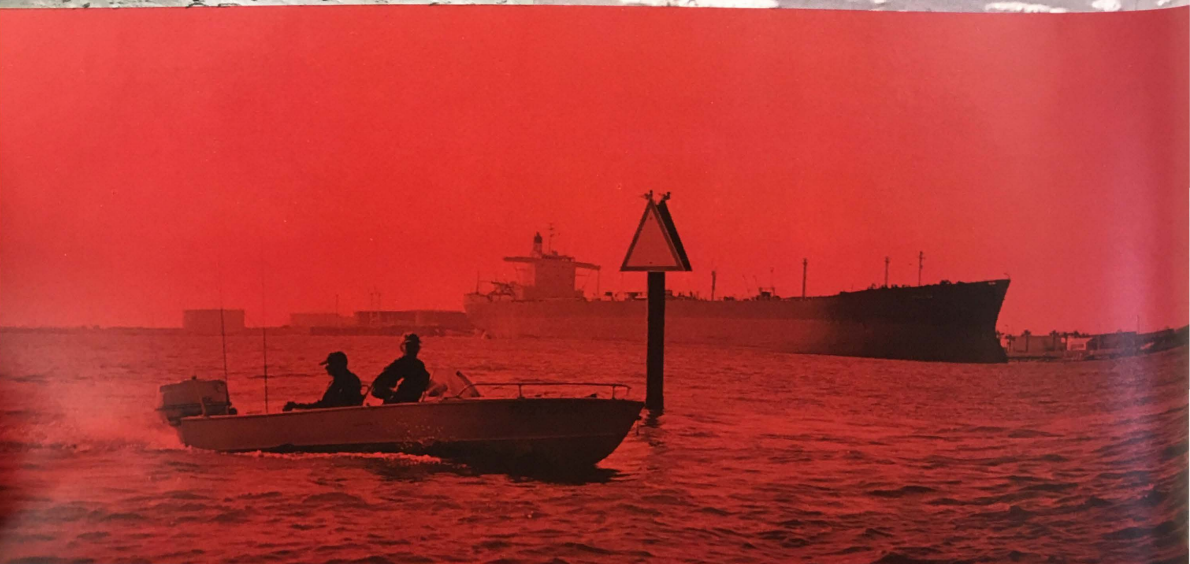
Occasionally a Padre Island beachcomber will find a golden Spanish doubloon surfacing from the wrecks of 16th century treasure ships. And if he looks sharp, for they are hard to see, he may see evidence of a modern treasure—the control valves of gas wells producing from beneath the dunes.

James M. McLaughlin, Padre Island National Seashore superintendent, observes that a number of recreation areas within the National Park System support mineral activities. This is in concert with the National Park Service's commitment to conservation. "We have working agreements with nine oil companies and four oil and gas transmission companies, and have had excellent cooperation from all of them. The 43 gas wells operating within the National Seashore testify to the fact that their mission is not in conflict with ours. You simply can't see the wells unless you search for them," McLaughlin says.

On the northern shore of Corpus Christi Bay sprawls the fishing village of Aransas Pass, home of one of the world's largest shrimping fleets, and the town of Port Aransas, a sportsman's haven. Between the two communities a visitor may see a number of major oil storage and shipping terminal installations. One of the largest is operated by Exxon Pipeline Company.

Amid the sand dunes of Padre Island National Seashore (top) hide the wellhead valves of 43 gas wells. On Harbor Island (left), Exxon Pipeline Company operates a crude oil storage and loading terminal where Exxon USA tankers take on crude for Eastern refineries. Just north of Corpus Christi lies the Aransas Wildlife Refuge (center right), home of the whooping crane and site of a major oil and gas field. Fishing is good next to the Harbor Island terminal (lower right), local fishermen have discovered.

By Keith Elliott, Exxon USA, *First Quarter 1973.*



Every two weeks an Exxon USA tanker takes on a half-million-barrel load of crude oil. The equipment and technology of oil is everywhere. Yet, on almost any sunny day (of which there were 241 last year) a giant tanker may share dockside space with numbers of small sports fishing boats which cluster at a productive fishing hole as porpoises frolic in the waters nearby.

In the Gulf of Mexico east of Padre Island, sports fishermen often anchor alongside drilling platforms where fish congregate. And on Laguna Madre, the lagoon between the island and the mainland, anglers drive to the water's edge on private roads built by Exxon USA for servicing wells in its Flour Bluff field. The company even provides litter barrels.

All this, then, is the scene of operations for what Commander Eaton believes to be the nation's best example of cooperative oil spill readiness. It is called the Corpus Christi Area Oil Spill Control Association.

No other group has brought together such a broad representation to combat oil spills, Commander Eaton says. "All levels of government are involved, and so is the oil industry, both financially and philosophically," he reports. "No other oil spill cooperative can make that statement," he adds with a grin.

The association's five-man board represents the interests of the Coast Guard, the U. S. Army Corps of Engineers, and the Environmental Protection Agency, at the federal level; the Texas Parks and Wildlife Department, Texas Water Quality Board, Texas Railroad Commission, and the General Land Office, at the state level; two navigation districts; the seaside counties of Aransas, Nueces, and San Patricio; the cities of Corpus Christi, Rockport, Aransas Pass, and Portland; and 12 oil producing companies, four refineries, and three pipeline firms.

Getting these numerous entities together was the idea and the challenge of Harry Franklin, a retired petroleum engineer. Softspoken and friendly, Franklin draws upon a lifetime of experience in oilfield jobs ranging from roustabout to advisor to the President of Brazil on oil producing problems. His petroleum engineering know-how is helping Corpus Christi to recover its oil and gas wealth while preserving the quality of its environmental assets.

Franklin went to work on the problem in 1967. As the city's first petroleum superintendent, he had the job of implementing a new ordinance hammered out by the Bay Drilling Committee, a group of prominent local citizens appointed by the mayor. "It was a realistic ordinance that both community and industry could live with," he recalls. The rule prohibited drilling within a mile of shore, limited the number of production platforms within a certain area of the bay, required a low-profile design with minimum visual effect, established lighting and safety standards, and required the clustering of well locations within each state tract. "All this meant more expense for the oil producers," Franklin says, "but they were happy to go along with it. This spirit of togetherness set the stage for the oil spill cooperative later on."

What really brought the cooperative into focus, however, was a widely publicized blowout in 1969 of an oilwell being drilled in California's Santa Barbara Channel. The city sent Harry Franklin to Santa Barbara to study the mishap and to learn from its consequences. "It isn't likely that such a thing could happen to Corpus Christi," he thought, "but we ought to be ready just in case."

Franklin points out that he wasn't concerned about spills from bay wells. Vast differences in both geology and circumstances make a repetition of the Santa Barbara blowout virtually impossible in Corpus Christi Bay. And wells producing in Corpus Christi waters all have automatic shutoff devices to prevent uncontrolled flow of oil. But the high volume of barge and tanker traffic and the large numbers of oil and gas pipelines, he felt, were a more likely source of spills.

Returning to Corpus Christi, Franklin reported his concern to Ed Harte, publisher and editor in chief of the Corpus Christi *Caller-Times*, and chairman of the Bay Drilling Committee. The two men recommended that the city take the initiative in setting up a meeting of representatives from federal, state, county, and local governments, and the oil industry. "Every oil company and every refinery had a man there," Franklin recalls.

"It was mostly industry," he recollects, that put up an initial $20,000 to "finance a study to see where to begin." Exxon USA and Exxon Pipeline each chipped in $1,000, plus the services of an Exxon USA manager, Jeff Barrett. He became a member of a five-man committee drawn from all segments of the community. The men visited every port in the country that had experienced a sizable oil spill. They talked with commercial fishermen, marine scientists, and petroleum chemists. They visited manufacturers of oil spill cleanup equipment. They interviewed port authorities, oceanographers, and maritime experts. They learned at first hand what could be done and what should be done to cope with spilled oil.

The CCAOSCA was the result. Franklin deplores the name. "We tried to get an acronym out of it," he smiles, "but it kept coming out CHAOS. That seemed counter to our purpose."

Because its members had done their homework, CCAOSCA was able to obtain federal grants to help defray the cost of acquiring suitable equipment. Sustaining memberships purchased by oil companies and local government bodies help pay administrative, training, and maintenance costs, Franklin explains.

Two metal warehouses, one at the Port of Corpus Christi and the other at Rockport, house a formidable arsenal: 8,000 feet of container boom, 5,000 bales of straw, a portable skimmer designed to operate in the bay's choppy waters, a straw blower,

(Upper left) Proper care enables Exxon USA to look for and produce oil and gas with minimum impact on the environment. (Upper right and center) Despite extensive petroleum production, the coastal areas of South Texas continue to harbor large populations of wildlife. The oil industry, sportsmen, and commercial fishermen (bottom) are good neighbors in South Texas.

and assorted mixers, sprayers, anchors, cables, hand tools, radio equipment, and a 38-foot crew boat.

And were he to need them, Franklin could call upon other resources available in the area. For example, at its Laguna Madre field headquarters, Exxon USA maintains a special warehouse for its oil spill recovery and containment equipment. Along with 50 bales of straw for an unlikely but conceivable shore cleanup, the warehouse holds 1,000 feet of boom to "fence in" spilled oil and a quantity of manufactured absorbents.

Recently, fishermen in the lagoon paused to stare at an odd sight. Exxon USA employee Irwin Glasser was casting puffed rice upon the waters.

A new way to chum fish?

No. He was testing a skimmer that Exxon USA would rush into service in the event of an oil spill in the lagoon. Mounted on a modified houseboat, the skimmer can get into shallow waters where heavier vessels would run aground, in order to retrieve lost oil. Glasser is Exxon USA's full-time environmental specialist for the Corpus Christi area.

"Our men are trained to get the skimmer and container booms into action in minutes," he explains. Because oil spills are rare, however, the men seldom have a chance to practice on the real article. "In training sessions, we use puffed rice," says Glasser. "It makes a good substitute for oil, for it acts in the same way as a slick does."

Except for continuing practice sessions, the equipment has been called into service only once. In October, 1972, Exxon USA received word that a small diameter pipeline was leaking into bay waters near the resort community of Fulton Beach. As Exxon USA wells were nearby, employees hastened to the scene and shut down the wells. They captured the slick and recovered the oil with a skimmer. In the meantime, others were attempting to learn who owned the pipeline. They found that it belonged to another company, but completed the cleanup regardless. "What was needed at the time was quick response," says Glasser. "With possible Exxon USA involvement and with our equipment available we felt a responsibility to act."

In the spirit of "We're all in this together," Exxon USA led a drive in 1972 to organize the Baffin-Laguna Oil Control Cooperative, known more simply as BLOC. Its seven members are companies with oil and gas interests along the Laguna Madre and further south in Baffin Bay. This is an area of sparse development and population where no one company has any major facility. But acting in concert, the group can provide adequate spill response.

"BLOC constitutes a pool of equipment and trained manpower standing ready to control any oil spill that might occur in our area," explains Jim Flatt, Exxon USA operations manager, who points out that waters in the Laguna-Baffin area are so shallow that special equipment and expertise are needed. "Of course we would help elsewhere in the event of an emergency," he says. "And, we in turn would look to our 'neighbor,' the CCAOSCA, for any support we might need."

For its part, CCAOSCA, can cope with anything short of a spill of the greatest magnitude, "a *Torrey Canyon* sort of thing," Franklin feels. "And were that to occur, we could combine our equipment and personnel with Exxon USA's and BLOC's and hold the effects of such a massive spill to a minimum."

Franklin has the authority to go into action the moment an emergency occurs. He does not have to clear his decision through governmental agencies. "Responsibility for a spill can always be fixed after it has been contained," he points out.

Operation of the association's standby equipment rests with crews of two marine engineering firms. In a series of "fire drills" during the past year, the crews have learned to deploy equipment and begin skimming within 45 minutes of their arrival at the scene of a "spill." "That's good," Franklin grumbles, "but not good enough. We'll keep practicing until we get the time down to 30 minutes."

If a massive spill should occur in the bay, Franklin reports that more than 500 volunteers would be called to the scene immediately. They would be supplied by Navy and Coast Guard units, police and fire departments, and civic groups. Among the latter are groups of students who have been taught how to clean oil-soaked birds by Dr. Henry Hildebrand, of the University of Corpus Christi, and Dr. John White, of Del Mar College. "We've even assembled a supply of bird cages," Franklin says.

All of which delights Coast Guard Commander Eaton. "These efforts make our job easier," he says. "If industry doesn't take care of these things, we'll have to do it. Industry here is proving itself responsible by getting ready for emergencies before they happen. And then, of course, we work to make sure they don't happen."

Exxon USA's South Texas Division manager, W. D. Stevens, underscores Franklin's and Eaton's enthusiasm for CCAOSCA. "The association represents a level of preparedness far beyond that which any one industry or individual governmental body acting independently could reasonably attain in one locality," Stevens says. He points out that CCAOSCA, BLOC, and Exxon USA's facility at Flour Bluff complement each other geographically and technically. He believes that each individual company, such as Exxon USA, should be prepared to deal with its own infrequent minor problems in areas where its operations are concentrated, and no other interests are involved. "This is why we have equipment at Flour Bluff," he says. And where no single company has extensive operations, then an industry group, such as BLOC, may be the best approach. Lastly, where companies are numerous and operations intensive, and both industry and public interests are involved, Stevens suggests that working together through a comprehensive organization such as CCAOSCA leads to the optimum level of preparedness.

For an emergency which it expects never to occur, Corpus Christi is ready. "It is the best example of environmental preparedness I have seen," Commander Eaton says. "And it took government and industry working together, to accomplish it." ■

to prevent a spill, go out and look

In 1968 Exxon International introduced a trial scheme of providing supplementary expertise to tankers during port turnaround to help crews avoid oil spills caused by equipment deficiency and human error. The programme went into effect in U.S. East Coast ports and was directed primarily toward chartered vessels whose crews might be unfamiliar with the increasingly stringent regulations against oil spills in U.S. ports.

The men employed to provide this expertise were annuitants, former ship masters and other officers familiar with tankers, company operating requirements, and the importance of spill prevention.

The trial programme rapidly demonstrated the value of sending "inspectors" aboard the ships. Consequently, its scope was extended in the United States, and similar programmes began to be adopted by the European affiliates. Exxon's British and Italian affiliates now have fully operating port inspection programmes. The U.K. affiliate uses two inspectors to cover Fawley and one at Milford Haven. The Italian affiliate employs some nine inspectors to cover the national ports at which it operates. The Norwegian affiliate also has a programme at Slagen whereby all crude-oil carriers are attended. This latter programme was begun on an informal basis by the Norwegian affiliate refinery at about the same time as the U.S. programme got under way. Other European affiliates are in various stages of developing their programmes. Virtually all should be operational by year's end.

The launching of an anti-pollution programme using inspectors for in-port shipboard checks requires consideration of several important factors. Personnel selection is critical. The person who boards a vessel in the role of inspector must be experienced in tanker operations and familiar with both ship and receiving terminal procedures. He must have the ability to communicate well with officers and men and with the employing affiliate, and have the ability to deal tactfully with people of all nationalities. Lastly, he must have status—the kind of peer status one captain has with another, for example, or one chief engineer with another. Obviously, annuitant masters and chief engineers who were formerly with the marine operating affiliates are a natural "first" to consider when selecting inspector-consultants.

Captain E. Thomas, an assistant master, on board a tanker at Fawley with an eye toward pollution prevention.

Equally important are the details of the inspector's job. His responsibilities are specific and are outlined in a contract between the employer and the inspector, who provides his services in the role of a consultant. Included are the following:

> Make sure that ships' personnel understand what precautions are necessary to prevent pollution, and ensure that these precautions are taken.

> Double-check to see that normal pollution prevention measures—such as the sealing of sea valves—have been carried out. (Such standard measures are the joint responsibility of both ship and terminal.)

> Remain with the vessel throughout its stay in port.

> Watch for details which may expedite turnaround, while keeping in mind that rapid turnaround is secondary in importance to pollution control.

> Let shore management know of any specific instances of pollution which may have been averted by the presence of an inspector. In effect, this represents "near-miss" reporting, which is recognized by most industries as a useful means of promoting healthy operational change. (The inspectors must also, of course, report in detail any actual spill that does occur.)

There are other details an inspector must attend to—including checks he must make on the vessels' operational capacity, and other checks using printed checklists for pollution control and safety. The pollution checklist is a document based on records of actual spills and their causes. The safety list covers the industry's standard regulations for vessels in port.

Experience with many vessels under the in-port inspection programmes in Europe and the United States has resulted in a sharper awareness of design and operating characteristics which might contribute to oil spills. These factors are given careful consideration by Exxon International when selecting ships for charter. ■

By Captain D. Murphy, Marine Operations Advisor, European Review, *Spring 1973.*

new knowledge of the north

The wrist deftly turns. The slender fiber glass rod whips forward. The eight-pound-test monafilament draws a glittering lure past an undercut gravel bank.

Glints of silver sky reflect from the spinning spoon. It is midnight in midsummer, 300 miles north of the Arctic Circle.

A strike! The rod wrenches nearly double as a 27-inch Arctic char battles the hook. The drag brake sings as the burly salmonoid runs, sounds and dances across an eddy on its tail—all to no avail. The angler is expert, and soon the fish is quivering on the tundra.

Quickly the fisherman weighs his catch, measures it, notes its sex, takes a sample of scales for determining age, and logs the data in a book of graphs. And then this young son of Scotland does a most un-Scotsmanlike thing: He gently releases his trophy unharmed in the stream.

Sixty times in six hours the routine is repeated by Dr. Peter McCart, fish ecologist from the University of Saskatchewan's Regina campus. Only as the night's work nears completion does Dr. McCart keep one fish to bake for breakfast at his wilderness camp.

Later, returned to civilization, Pete McCart will confess of his research techniques: "Much as I try to explain to my sportsmen friends that my angling is all in the interest of science, they give me that knowing look. 'Nice work,' they say, 'if you can get it!'"

But the annual fishing expeditions by Dr. McCart to Alaska's northland are indeed of scientific stature. The discovery of oil in the American Arctic has evoked proper concern for the continent's last frontier. As a consequence, no less than 400 scientific inquiries into the Alaskan environment were initiated, or given new emphasis, by oil activity. Some of these studies are complete; some are continuing. While Dr. McCart surveys the North Slope fishery:

> Deep in a ditch on a rugged Brooks Range pass, a graduate student of archeology brushes mud from a stone tool left by one of America's earliest inhabitants.

> Shivering in his fur parka, an English ecologist peers through his binoculars from a camouflaged blind, mapping nests of hawks.

> At the Eskimo village of Barrow, northernmost town of the United States, a technician from a U.S. Army cold weather lab wires a computer to heat sensors buried in test plots of tundra.

> Alongside a new road to the Yukon, agronomists inspect bulldozer scars healed over with lush carpets of grass, sown by native Alaskan workers.

> A team of biologists at the natural tar seep of Cape Simpson finds evidence that certain strains of bacteria are capable of digesting crude oil.

> From a Huey helicopter crabbing across the North Slope, a retired senior vice president of Ducks Unlimited estimates 20,000 caribou in a single herd.

Involved in the inquiries are all sorts of institutions—fish and game departments, US and Canadian universities, the unique Naval Arctic Research Laboratory, state and federal land offices, agricultural research stations, and ecology staffs of oil companies. A substantial contributor of money and men is Alyeska Pipeline Service Company, which proposes to build an 800-mile pipeline to transport North Slope oil southward to the ice-free port of Valdez. Seven oil companies, Exxon Company, U.S.A., among them, are members of Alyeska.

"No engineering project in our history—public or private—has had the degree of public consideration the pipeline is receiving," says Alyeska President Edward L. Patton. "Our share in this concern is demonstrated in the ecological studies we're supporting."

Everything about Alaska—the pipeline included—is difficult to place in perspective to the state's great size. Outsiders (Alaskan term for all non-Alaskans) of the lower 48 states have had no country in the 20th century to compare to Alaska in remoteness and scale. Alaskans often complain that the rest of the nation is near-sighted in middle-age. Alaskan resentment is revealed in an Anchorage saloon sign:

"Texans beware! We may cut Alaska in two, and make Texas No. Three."

The geography is available. Superimposed on a map of the lower 48 states, Alaska extends from California to the Carolinas. Alaska has four time zones. An Alaskan glacier, one of dozens, could bury Holland. One game preserve is larger than Hungary. In Alaska are 10,000 rivers and streams and three million noteworthy lakes. Of Alaska's 586,000 square miles, Alyeska's pipeline right-of-way would total just eight square miles. If Alaska were thought to be a 20-foot-square rug covering 57,600 square inches, the right-of-way would amount to one square inch.

All that said, Alaska's north country is vulnerable as well as vast. Around and beyond the storied Yukon River, land and life are especially sensitive. Conservation vigilance focuses on the north. Native plants in severe climate and poor soil recover slowly when injured. With relatively few types of creatures, food chains may be broken if just one species is lost. In certain ice-rich permafrost areas, the

By Don Dedera, Humble Way, *Second Quarter 1971.*

Brants are among the many varieties of migratory fowl which nest on Alaska's North Slope.

"Alaska's Arctic is a dangerous place for preconceptions."

earth itself might collapse if abused.

"There's much we don't know about permafrost," says Max Brewer, for eight years the director of the Naval Arctic Research Laboratory. "But on the other hand, we know a great deal about how to handle this material." Brewer explains that permafrost is simply ground that has been frozen for two years or more. It may be low in moisture such as the rocky terrain of the Brooks Range or in well-drained areas. Or it may be high in moisture and contain much ice. Permafrost is usually insulated with a mat of something organic, such as tundra, which keeps it from melting during the Arctic's short summer. "We've been developing permafrost engineering for many years," Brewer says. "It wasn't just discovered yesterday."

Still, he adds, wryly, "Alaska's Arctic is a dangerous place for preconceptions."

Initially, pipeline engineers thought most of the line could be safely buried; that the permafrost was relatively free of moisture along most of the route; that a line filled with warm oil largely could be put out of sight. But to be sure, they took more than 3,000 test borings, seldom more than a quarter of a mile apart. These field studies indicated where the line could safely be buried and where it should be elevated to avoid melting permafrost.

"The only way we could find this out was to poke holes in the ground and analyze the cores," says Dr. Richard B. Schwendinger, liaison biologist to Alyeska engineers. "To check on the accuracy of these cores, we even drilled holes 30 inches in diameter and lowered men on cables to visually inspect the permafrost."

Dr. Schwendinger specializes in restoring vegetation. He points out that ground cover prevents erosion of soil anywhere, and is especially important where ice-rich permafrost occurs.

"Where construction disrupts ground cover, the obvious solution is rapid replacement of the cover," Schwendinger says. "Fortunately we can draw on 40 years of Alaskan farming experience, and Arctic know-how from Canada, Scandinavia, and even the Soviet Union."

Fertilizer and grass seeds produce ground cover for protection of topsoil and permafrost.

On dozens of plots scattered throughout Alaska germination experiments have shown which varieties of plants might serve as temporary covers. At the same time Alyeska, individual oil companies, and government agencies have pushed studies of native plant propagation as the ideal long-term answer to disruption.

A dramatic example of revegetation can be seen along the new supply road from Livengood ghost town to the Yukon. In 1970, grasses sown by Alyeska crews along the roadway sprouted and held the soil. Mulches of fiber, straw, or excelsior provided insulation for permafrost. Fertilizer broadcast with the seeds brought about fast, dense growth. Most successful were oats of Canadian origin. In 1971, Schwendinger expects an even better performance from spring rye grass, which flourished in experimental plots last year.

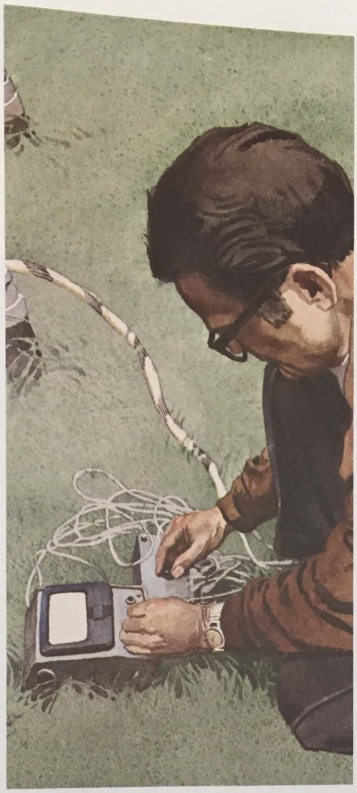
The presence of a warm pipeline complicates Schwendinger's ground cover problem somewhat. To observe it first-hand, a 600-foot-long, full-sized pipeline was buried in the permafrost at the University of Alaska's campus. Heated to 140 degrees, it simulates an operating pipeline. In spite of winter air, temperatures as low as minus-70 degrees, the ground immediately above the pipeline remains about 100 degrees. Here, the search is for plant species that can tolerate such a span of temperatures and survive dryness.

The problem area right above the pipeline is very narrow, and alternatives to growing plants could be used. "Where revegetation is impossible," Schwendinger says, "we have organic mulches, or if need be, we could go to concrete grout."

Before the recent stampede in research, few people knew much about the workings of the tundra—that marvelous mat of plantlife that in the summer insulates the Arctic flatlands from deep thaw. With backing by the National Science Foundation and the petroleum industry, the United States joined the International Biological Program with a comprehensive Tundra Biome Project. The ambitious goal: to learn what makes the tundra ecosystem work.

Principal investigators are Dr. Jerry Brown of the Army's Cold Regions Research Laboratory at Hanover, New Hampshire, and Dr. George C. West, of the University of Alaska. Of their many investigations, one had to do with the effect on tundra of crude oil. Their preliminary findings indicate that North Slope crude oil spilled on test plots of tundra did not produce severe damage to the vegetation. They found that oil will decompose naturally in Arctic soils, and that generally, the wetter the soil, the more it will resist oil damage. Regrowth of native sedges and grasses prevented erosion in plots which were deliberately treated with crude oil. Although certainly not a recommendation for oil spills, the Tundra Biome Study does suggest that an accidental oil spill would not necessarily blight tundra forever.

"I have every reason to believe our extensive ecological research activities will result in a long-term improvement in man's relationship to the Alaskan environment."



Biologists are searching for plant species capable of tolerating a wide span of temperatures.

Progress has been made, too, in finding plants to restore scarred tundra. Ecologists of Atlantic Richfield succeeded in growing several types of Canadian grasses in vehicle tracks left by unwitting early-day explorers. And foresters of the Alaska Division of Lands announced results of field tests of vehicles. They report that tundra can support travel without damage in the summer—but only by vehicles with wide, flat tracks with shallow lugs.

Where little was known of Arctic vegetation, even less was known about wildlife. Outdoor study, and lots of it, has produced an extensive body of knowledge useful to environmentalists.

Of all the Arctic's creatures, the caribou has become a symbolic victim to many Americans outside of Alaska. The people of Alaska, outnumbered two-to-one by caribou, assume a more practical attitude toward the noble reindeer of the north. Natives hunt caribou with no limit the year around to feed sled dogs.

To count the herds, Alyeska enlisted the English ecologist, Bryan Sage. He found that the migration trails of the 440,000 caribou were not as static as once supposed. Sage reports that only six percent of the animals normally would cross the right-of-way of the proposed pipeline enroute to lambing grounds. Few animals use Dietrich Pass, where the right-of-way traverses the Brooks Range, as a migration route. And through Dietrich Pass, the pipe can be buried, Alyeska engineers say.

Since caribou can migrate 40 miles a day, and willingly cross roadways and gravel ramps such as those proposed for elevated pipe, Sage concludes, "I cannot see an above-ground section of this length being anything other than a minor and local inconvenience." Sage points out that caribou for centuries have prevailed over natural barriers far more formidable than a pipeline—ice-choked rivers, mile-high mountains, and ambushes by wolves.

Biologists such as Okanagan College's Dr. Peter Elliott studied the behavior of Alaskan fauna as well. They found the lambing grounds of Dall Sheep in Atigun Canyon to be in high alpine valleys, well away from the pipeline. In checking the populations of moose, grizzly bear, gray wolf, and Arctic fox, they found that the numbers of moose increased following completion of an oil field on the Kenai Peninsula, and that moose were extending their range into the North Slope.

Skip Braden, Alyeska Environmentalist, comments that bears might become a problem wherever garbage is dumped. "The camp in Alaska that doesn't enforce strict garbage rules is going to have bears as guests," he says. Procedures developed at Yellowstone Park for handling the occasional outlaw bear could be used. "Trouble-makers can be trapped alive and transported away from a camp," Braden suggests. But Exxon and Alyeska expect no trouble. Their crews routinely "backhaul" all garbage to Fairbanks for sanitary disposal at the city's facilities.

For some birds of prey Alaska is a last retreat. Bird lovers have asked if commotion of construction could drive off peregrines, falcons, eagles, and hawks from the craggy breeding nests which they use year after year. To find out, Environmentalist Sage and experts with the U.S. Bureau of Sportfish and Wildlife traveled the length of the pipeline right-of-way and counted the birds of prey. Bird populations were low (two to three pairs per square mile) and the nearest nesting site was half-a-mile from the right-of-way.

Preserving fisheries came under the scrutiny of Dr. McCart, the scientific angler. "We're well along in knowing which streams crossing the pipeline route are productive, and what types of fish they contain," he reports. "Northern fish become sensitive to disturbance during spawning season," he says. "To protect fish populations, construction near streams should be timed to occur before or after spawning season. Also construction methods might be employed which don't stir up silt in the waters," he advises.

In addition to the present and the future, the distant past has become part of current investigations. Financed by Alyeska grants, Dr. John Cook, anthropologist of the University of Alaska, and a 15-man team, reconnoitered the entire route for the pipeline. He found nearly 200 sites worthy of investigation for their evidence of early man in Alaska. His probing produced a flint spear point similar to points found in the Lower 48, confirming the antiquity of man in Alaska. Another discovery produced evidence documenting the introduction of early historic goods to Eskimo cultures. His team accomplished "four years of work in one" Dr. Cook says, thanks to helicopter transportation furnished by Alyeska.

It is the kind of cooperation and assistance that lends credibility to a statement of Alyeska President Patton, who says, "I believe that our extensive ecological research activities will result in a long-term improvement in man's relationship to the Alaskan environment." ■

investigating the environment at Valdez

The problem is vexatious, immediate and increasing. To solve it, Bill Shiels activates a precision-made, thoroughly tested, highly effective instrument standard in Alaskan oceanography:

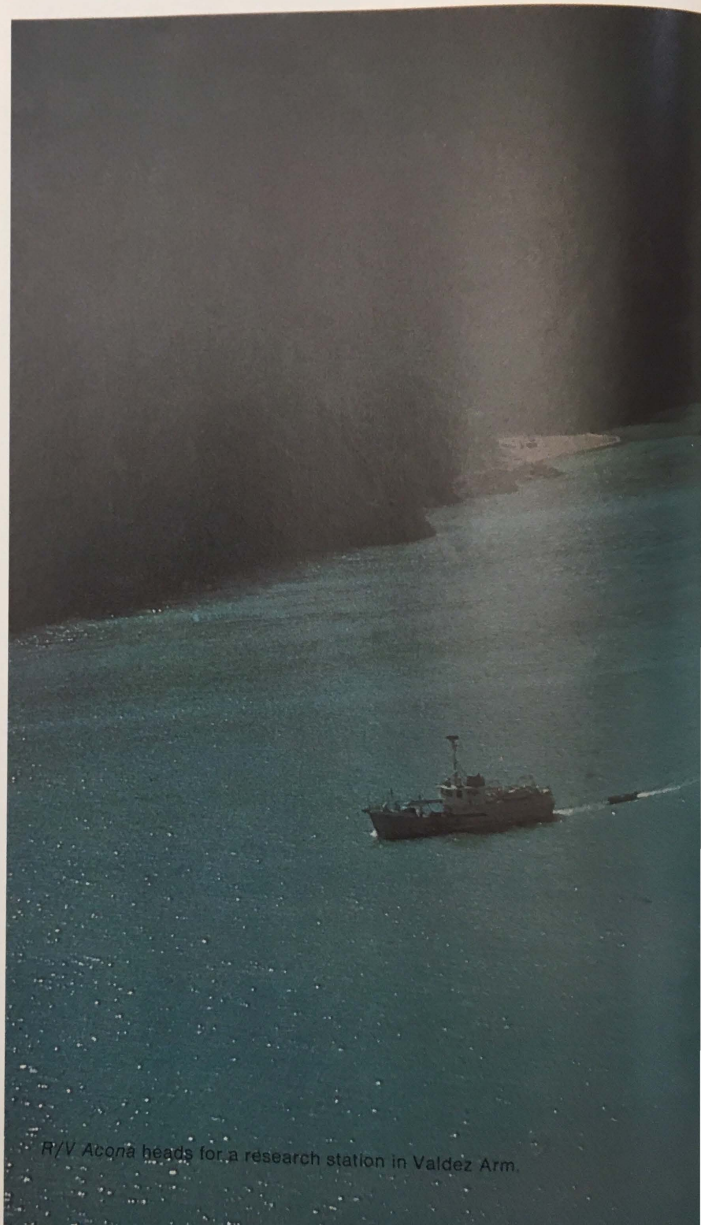
"... *Stick, round, tapered, of straight-grain ash, exactly 1.067 meters long, maximum of 69.5 millimeters in diameter, stamped with an oval trademark, "Louisville Slugger."*

Swinging his big league baseball bat, Shiels shuffles up and down the slippery, heaving decks of the Research Vessel *Acona*. He flails away at the crusts of frozen spray clinging to rails, jackstaff, winches, wire ropes and superstructure. With every smite, shards of ice fly away on a wintry wind. And the *Acona*, relieved of her burden, makes her way toward another station in the Valdez Arm of Prince William Sound. Bill Shiels stows his bat in the pilot house, and brings into play yet another apparatus familiar to northern latitudes, a snow scoop. Hampered by bulky clothing, Shiels clears slush from a solar meter, from seawater incubators, from coils of plastic tubing leading to a laboratory aft.

If "exploration is the sport of the scientist" (Auguste Piccard), the men of the *Acona* are participating sportsmen in a championship academic expedition. Their contest is unique in oceanography: to pursue history's first comprehensive, long-term study of a pristine fjord.

"To my knowledge," says team leader Dr. D. W. Hood, "nowhere in the world has advanced oceanography been employed in this detail for so long a time in the thorough investigation of a fjord estuary before man became a significant influence." Dr. Hood explains that Valdez Arm, unlike most other fjords, is very nearly a virgin body of water. With men and equipment which he says are the very best, he has been examining the physical, biological and chemical composition of the fjord for over a year. "We're establishing baselines for the future," Dr. Hood says. And he adds, "We wish somebody could have done this

By Don Dedera, Humble Way, *First Quarter 1972.*



R/V *Acona* heads for a research station in Valdez Arm.

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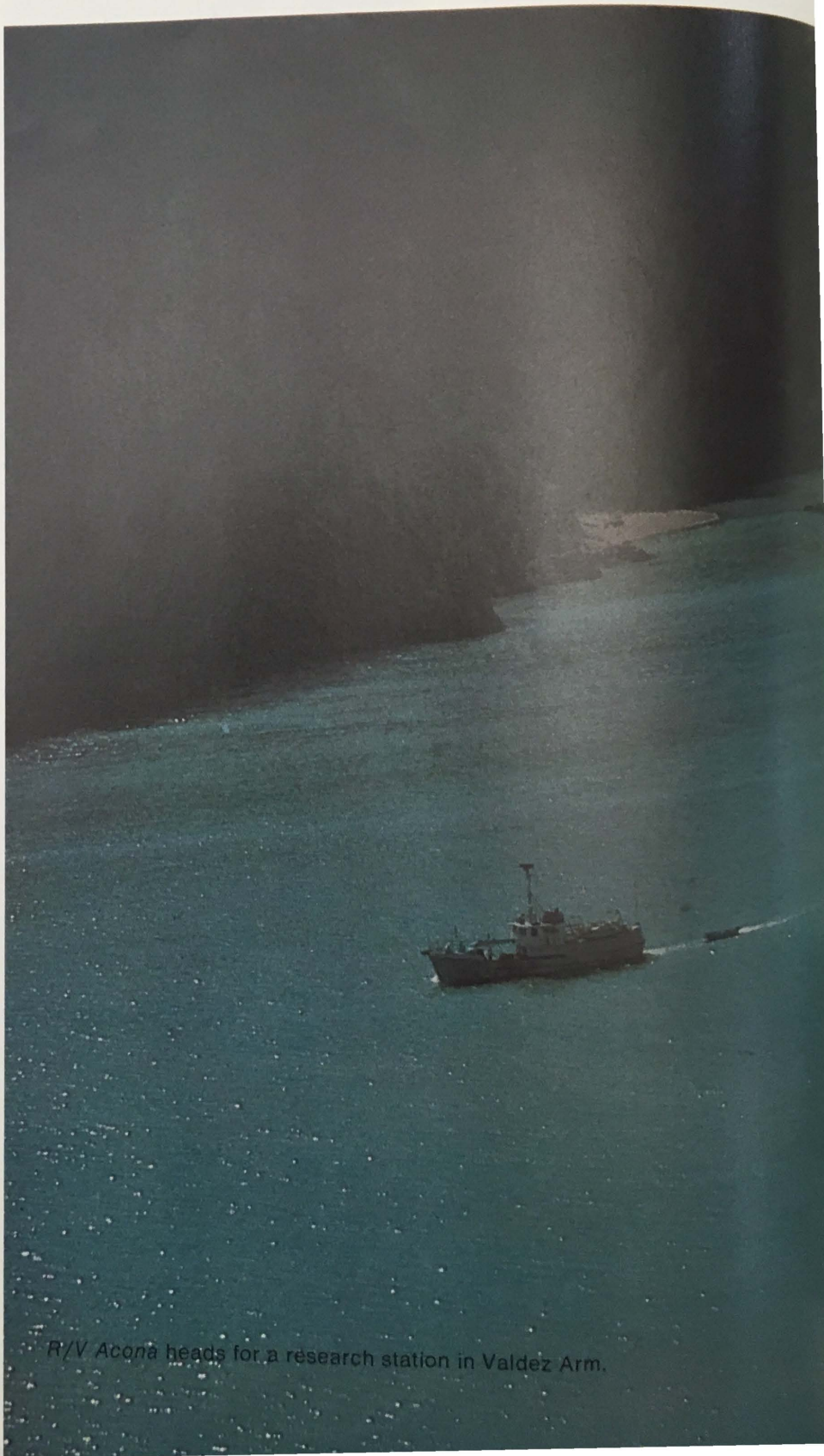


R/V Acona heads for a research station in Valdez Arm.

in San Francisco Bay 200 years ago!"

Need for the Valdez Arm studies arose with plans for an 800-mile overland pipeline to transport oil from Alaska's North Slope. Valdez (pronounced Val-*deez*) was selected as the southern terminal of the pipeline, the port where tankers might take aboard oil for delivery to the U. S. West Coast. Along with its deep natural harbor, Valdez is blessed with two other advantages—a relatively warm climate in winter which prevents thick surface ice from forming, and stable bedrock sites for shoreside facilities.

Of priceless value, this sheltered inlet is also spectacularly beautiful. Dark mounts rear full-born from sea level to snowy caps 6,500 feet above the fjord. In the narrow, densely wooded valleys, rivers spring as waterfalls from melting glaciers creeping down from South Central Alaska's mighty Chugach Mountains.

Against so grand a scale, the marks of man are faint. Whalers anchored here in the 1800's, and at the turn of the century, thousands of sourdoughs climbed a short-cut through the mountains surrounding Valdez to the gold fields. Their trail became the Richardson Highway, but a hoped-for railroad went another route. So Valdez remained a cozy tourist town of 600 peaceful residents until its future date

Dr. Mark Pelto, oceanographer on the staff of the National Marine Fisheries Service, examines facilities aboard the Acona.

Dr. Dale Brandon, research geologist and oceanographer with Exxon notes fathometer readings.

with destiny on that Good Friday of 1964.

That day, the mightiest earthquake on record in North America rumbled out of the Chugach. Valdez, built on a sandy river flat just 35 miles from the epicenter, caught the full brunt of a temblor that released the energy of 500,000 Hiroshima-size atomic bombs. The loose sediments of the delta quivered like gelatine in a bowl, and the buildings of Valdez came tumbling down. Of the quake's 115 victims, 31 perished at Valdez, more than anywhere else.

Thus, Valdez gained a reputation for vulnerability. But later, following "the most intense study of a natural disaster on earth," the experts said otherwise. The U. S. Army Corps of Engineers recommended a new townsite on solid ground "in an area not subject to instability in the event of a future earthquake." There, four miles west of Old Valdez, survivors built their town anew. On bedrock across from the new town Alyeska Pipe Line Service Company proposes to place its tanker docks and oil loading facilities.

Yet even if Valdez was a logical place for the pipeline, would such a facility pose a threat to the unspoiled fjord?

Dr. Hood was among the first to wonder. Author of some 75 scientific papers, director of the Institute of Marine Science at the University of Alaska, past chairman of the Alaska Coast Commission, the 53-year-old biochemist proposed a study to assist "the maintenance of environmental quality at Port Valdez."

The philosophy for such a study: "The public, state, and federal agencies, and private individuals, are all vitally interested in developing this area, but not at the expense of sacrificing environmental quality." And further, "Development of natural systems must proceed under conditions and restraints that are compatible

Team leader Dr. Donald Hood, left, director of the Institute of Marine Science, University of Alaska, discusses research data with Dr. Pelto.

to multiple use resources. This is the basic attitude of the Institute of Marine Science, and the work proposed here is directed to accomplish those ends."

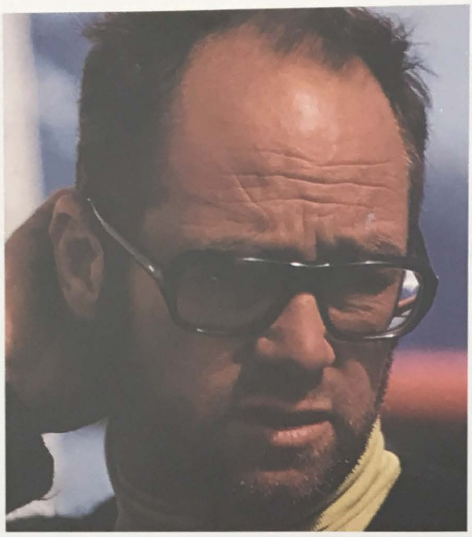
Alyeska Pipeline, in which Exxon Company, U.S.A. is a partner, agreed that studies were needed as a precaution against possible damage to the environment. With funds from Alyeska, the voyages of the *Acona* began, in May of 1971. Thereafter, in all seasons, she revisited established stations to sample marine life, to measure currents, to probe the depths. Fact by fact, the peculiarities of Valdez fjord began to take shape on the graphs and charts of the little vessel.

Admiration of the *Acona* requires a respect for function. She was built in 1961 specifically for oceanographic research. More turtle than porpoise, at the beam she exceeds a third of her 85-foot length, making space for wet and dry labs and berths for nine scientists in addition to the crew. An auxiliary propeller forward aids maneuverability; electronics include autopilot, loran, direction finder, depth recorders, and radiophone; deepsea winches and hydrographic davits clutter her decks. Still another research vessel, the *Ursa Minor*, is available from time to time for use as a stationary laboratory.

Although in the beginning oceanographic information was scarce, some scientific data were known about Valdez Arm. Coast surveyors had charted its dimensions. The climate was marine, with cool summers and moderate winters, cloudy skies, and 62 inches of annual precipitation, much of it dense, moist snow.

The *Acona* confirmed earlier reconnaissance which suggested that Valdez was a typical Alaskan fjord. It had been gouged out by a glacier at a time when great amounts of water were stored in polar ice sheets. When the planet warmed up and the ice melted, the ocean rose to drown the U-shaped valley.

At its greatest depth Valdez Arm is 800 feet deep. In common with most fjords, just outside its entrance is a submerged sill deposited by the vanished glacier. The fjord receives considerably more fresh water from river run-off and moisture-fall that it loses to evaporation.



Above, the captain of R/V Cripple Creek, *Pete Shepherd, awaits the outcome of a drift survey. Below, five-ton sections of 48-inch pipe are stored at a site near Valdez.*

"So here we have a classical estuarine circulation," says Dr. Robin D. Muench, 29-year-old physical oceanographer and outdoorsman. Dr. Muench will write the final report of the *Acona's* physical oceanographic findings.

Dr. Muench explains that water from rivers flowing into Valdez Arm tends to flow directly toward the mouth of the inlet as a surface layer of low salinity. Deeper down, a layer composed primarily of seawater flows in across the sill. Tides induce some circulation, he explains, and winds and atmospheric pressure also push the water around. "It's all very complicated," says Dr. Muench, "but important, because these are the circulation processes by which an inlet like Valdez continuously renews its waters."

To establish the important facts of water movement, the inquiry at Valdez employs current meters, parachute drogues, dye studies, and Nansen bottles to fetch samples of water from various depths.

Of these, Dr. Muench considers the dye studies among the most important. They help to determine how contaminants might be diffused within the fjord.

Rhodamine B, a dye detectable in very small quantities, serves as a "contaminant" in Dr. Muench's diffusion studies. From an 18-foot skiff anchored on a station, he releases a quantity of dye at a known depth. As the *Acona* circles the skiff, hoses lowered over the side to the proper depth draw in water and pass it through extremely sensitive detectors. "If all goes well, we delineate a plume of the dye," Dr. Muench says. "The procedure is also qualitatively useful in learning about currents, tides, eddies, and turbulence."

Careers of the scientists on board the *Acona* indicate the diversity of disciplines gathered under the umbrella term of oceanography.

Dr. Muench has led three expeditions in physical oceanography to the Eastern Arctic. Dr. Hood's experience goes back to the secret Manhattan atomic energy project of World War II. In his 15 years in

oceanography, Dr. J. J. Goering has studied biological production off the coast of Peru, and nutrients from the waters of the seven seas. Dr. P. J. Kinney has written numerous papers on the fate of hydrocarbons in northern waters. In related work, Dr. D. K. Button has become an expert in "biodegradation," the process by which oil is broken down by bacteria in the sea. Dr. Howard M. Feder, marine biologist, heads a three-man team studying the benthic fauna (the bottom-dwelling animal communities) in Port Valdez. His research, which has produced several important papers on the marine environment, has led him from the coastal waters of Southern California to the Chukchi Sea. Dr. G. D. Sharma is a geological oceanographer who has studied the sedimentary processes of river deltas in India and the Bering Sea. Now he is studying the nature of the suspended and bottom sediments of Valdez Arm. Then there are the willing and tireless professionals such as chemist Charles Patton, who spent two summers studying salmon eggs on Admiralty Island, and David L. Nebert, physical oceanographer hired to analyze data from the *Acona* cruises.

And there is William E. Shiels, who—beyond his talents with baseball bat and snow shovel—is an accomplished biologist. His studies at Valdez cover the primary production of organic matter and the effect of petroleum on growth of native organisms. Both are vital. For even casual inspection reveals the fjord to be biologically rich. Runs of herring, and silver and king salmon are seasonally enormous. Sports fishermen from Port Valdez also catch red snapper, halibut, and crab. Seals, whales, porpoises, and sea otters frequent the inlet, as do migratory waterfowl. Bears, mountain goats, beavers, and moose call the surrounding mountains home.

"But we're looking at less conspicuous life," Shiels says. "We're examining the algae and plankton upon which the higher forms feed." He explains that the cold waters of Valdez are surprisingly productive and sometimes bloom richly with marine life, although the number of species is small compared to a coral atoll, for example. At 26 biological stations in the Valdez Arm, Shiels and other scientists sample chlorophyll, nutrients, plant and animal plankton, seaweed, and eelgrass. Experiments continue on the effect of oil on plankton. In another type of research project, a team of biologists are taking grab samples of the bottom for a study of invertebrate animals.

Motorboats and seaplanes aid the R/V Cripple Creek *in carrying out a survey of water currents.*

The pleasant workdays of the fjord's shirtsleeve summer yield all too soon to windy, wet, and cold winter, which for the *Acona*'s crew, turns easy chores into grinding, arduous labor. With the *Acona* pitching on wind-rolled seas, men encumbered by heavy clothing must be doubly careful. A fall into the fjord's 40-degree water would mean death in less than ten minutes. Numb with cold and swathed in bulky garments, men work less efficiently. "You find yourself doing dumb things," Shiels grumps. "You drop wrenches over the side or trip Nansen bottles before you get the whole cast set."

A three-day snowstorm had Shiels constantly on deck sweeping snow from bottles of phytoplankton in the seawater incubators and from meters recording solar energy. Freezing plankton nets became stiff and unwieldly in rubber-gloved hands. Ice-glazed decks provided treacherous footing, and icicles hampered the use of equipment. "That's when we broke out the baseball bats," Shiels recalls. In the labs, chemicals and electronic gear had to be secured against the ship's constant rolling and tossing.

Dye experiments, difficult under ideal conditions, became doubly complicated. A skiff on one station acquired an unwelcome cargo of two feet of snow. To prevent dye from freezing, scientists installed heating elements in their containers. "Under the circumstances, we did very well," says Shiels.

On the young side of 30, Shiels is one of a generation that has expressed much concern about pollution, depletion of natural resources, and environmental quality. Married, father of one child, he is nearing completion of work toward a master's degree at the University of Alaska. He has chosen a career of positive action toward preservation of the life systems of nature.

"That's the rewarding part of this work for me," he says.

It's not only research for the sake of research, but research directly related to a question of environmental quality. On the Valdez fjord. Aboard the *Acona*. Mixing messy red dye. Fighting frozen metering wheels. And keeping handy a snow scoop and a baseball bat. ■

permafrost

The image of Canada as a land of ice and snow has a solid basis in fact. Half the country's ground is gripped permanently in a freeze. The condition is known as permafrost, and it's difficult to work with, delicately balanced, seasonally adjustable and the most important factor facing anybody who wants to operate in the North. It includes all types of ground from soggy peat bogs through gravel mounds to solid rock. And despite its fearsome reputation, anything can be built on permafrost that can be built anywhere else. The trick is understanding the stuff and taking its properties into account first.

"Its properties vary tremendously within short horizontal and vertical distances," says Dr. Jack Clark, soft-spoken supervisor of earth sciences for Northern Engineering Services Company Limited. "But permafrost soil is not really a lot different from the soil you'd find in warmer regions unless it has a high ice content."

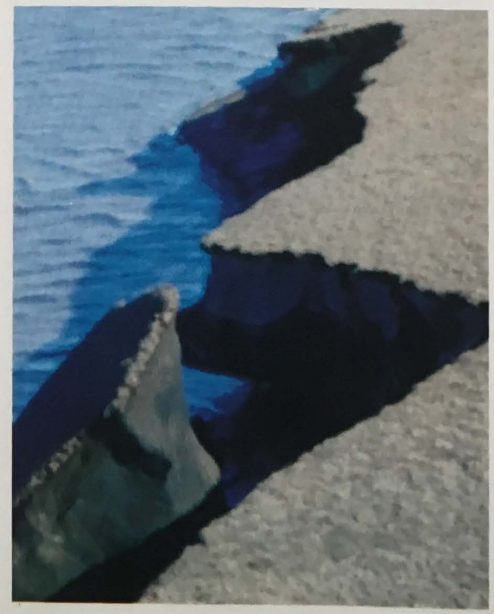
According to Dr. Clark, the ice in the soil gives it more strength than it would normally have. And many engineering problems can be avoided simply by preserving the ground in its frozen state. "If ice-rich permafrost is kept intact it's virtually like solid rock. You can build anything on permafrost that you could build on unfrozen soils, provided you have a proper design," says Dr. Clark.

By Jean Martin, Imperial Oil Review, *Number 4, 1973.*

But the reverse is true when the permafrost thaws. If ground ice forms a large proportion of the soil volume, it turns to water creating a slurry. "When ice reverts to water the ground loses its stability," explains Dr. Clark. "In the thawed state it may have little or none of its former strength left."

Significantly, a well-drained soil like sand or gravel is not normally subject to the same hazards as a fine, silty soil. In well-drained soils and in soils with a low ice content thawing does not result in lost volume. As an example Dr. Clark tells of the Canol Road, built during the Second World War from Norman Wells over 620 miles of permafrost to Whitehorse. After almost 30 years the road, abandoned at war's end, is still intact.

Permafrost breaks from the shore five miles west of Imperial's artificial drilling island.



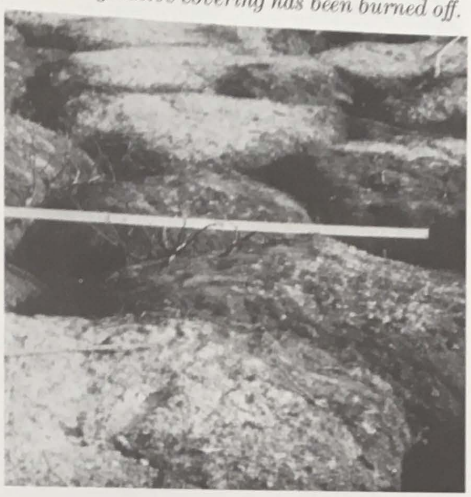
While permafrost can present some unusual problems, its origin is simple. If ground material, such as rock and soil, remain frozen for at least one complete year, they qualify as permafrost even if the condition is not sustained longer. Dr. Roger Brown, of the National Research Council of Canada, explains that the frozen condition will penetrate deeper each year as long as the same climatic conditions prevail. The resulting thickening is a slow process and scientists studying the permafrost on Cornwallis Island in the Northwest Territories calculate it penetrated to a depth of 1,300 feet at Resolute over a period of 10,000 years. Does this growing ever stop? "Yes, it does," says Dr. Brown. "Somewhere far below the earth's surface, heat from the planet's core will eventually balance the cold."

In Canada, the greatest thickness of permafrost is in the Arctic region where the summers are brief and the winters long and severe. In this land the freezing has spread to every stone and clump of earth with the single exception of those beneath bodies of water that don't freeze to the bottom. It is known as continuous permafrost, a condition that extends southward almost 2,000 miles from the northern tip of

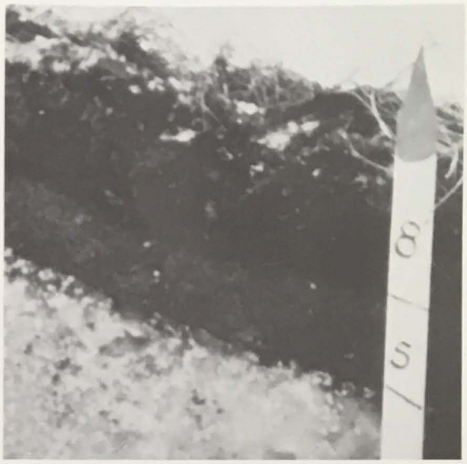
It can be rock, gravel, sand or silt, and it's no trouble, really, so long as it stays frozen.

Test trenches reveal how the permafrost will react during construction of an Arctic pipeline.

Bumpy-looking tundra is typical of permafrost. Here revegetative covering has been burned off.



Ice can make up a large part of the permafrost soil, only a thin top layer thawing in summer.



Ellesmere Island in the high Arctic to the southern edge of Hudson Bay.

In the West, the southern edge of this zone crosses the Mackenzie River in the vicinity of Arctic Red River. From there it begins a shallow arc to the southeast past the north shore of Great Bear Lake into Manitoba and around the tip of Hudson Bay to the mouth of James Bay. Farther east it crosses northern Quebec and southern Baffin Island. South of this area of total cover the permafrost becomes patchy and, according to Dr. Brown, is no more than 200 feet deep. The patches are large and widespread at the northern edge of this "discontinuous zone"; they get smaller and thinner until the zone fades out at various points inside the provinces.

Overlying Canada's permafrost is a thin blanket of earth that reacts to the changes of the seasons. Because it freezes and thaws annually, scientists call this cap of earth the active layer. According to Dr. Brown: "It's not actually a part of the permafrost but rather a medium for the exchange of heat and moisture between the permafrost and the atmosphere. Its characteristics and its behavior, when disturbed, have to be considered in the design and construction of anything built on permafrost."

In patchy permafrost the active layer ranges from two to 10 feet deep but in the continuous zone the depth will vary only from one-and-a-half to three feet. Local variations in the layer's thickness depend

Canadian Arctic Gas Study's Sans Sault test site is helping to determine effects of buried and elevated pipelines on permafrost. Big balloon tires (right), avoid damage to the thin blanket of vegetation that insulates the permafrost.

on such things as vegetation, drainage, snow cover as well as soil type. Vegetation is one of these factors most easily altered by man. Very often, a delicate balance exists between the ground and the atmosphere, one that is controlled by an insulating mat of grasses, moss and small plants. In patchy or discontinuous permafrost, for instance, frozen ground can generally be found under mounds of peat. In summer, when it is dry, the peat will insulate the ground from the sun's heat, but in winter the peat becomes moist and offers little resistance to the cold. If the peat is removed the underlying ground loses its protection. "And it's often in a very delicate state," explains Dr. Brown. "The ground temperature might only be a fraction of a degree below freezing. Any rise in temperature will likely cause it to thaw."

Such a rise occurred when a forest fire threatened Inuvik in 1968. Firefighters had to strip the vegetation from some 25 miles of fire breaks in an effort to save the town. Now, there are trenches as deep as 10 feet in the cleared areas where the ground thawed and slumped—a condition that occurs when the ice in the soil melts, reducing the soil's volume so that it contracts to fill a smaller space.

Today, knowledge about permafrost is increasing rapidly, but for centuries it was little known and even less understood. Explorer Martin Frobisher had to deal with it when he arrived in Canada in 1576. Besides a northwest passage, Frobisher was looking for gold on Baffin Island, but preliminary excavations were thwarted when he encountered frozen ground.

Then in the 18th century, James Isham noted in his "Observations on Hudson's Bay, 1743" that even in summer it was difficult to dig very far into the ground. He wrote: "...the frost is never out of the ground in these parts."

At the close of the 18th century and throughout most of the 19th, only scattered observations were made, mostly by fur traders and explorers. To that time, little settlement had taken place in the North. Roads were almost non-existent and the simple buildings that were erected had little effect on the permafrost.

In large northern settlements like Inuvik, sewers and water supply are protected from freezing in above-ground, insulated boxes called utilidors.

Then, in 1889, the Royal Geographical Society's permafrost committee produced the most ambitious report on frozen ground completed to that period. Attempts had been made to determine the depth of permafrost and its geographical limits through observations at 22 different locations. And about the time of the report, according to Dr. Brown, American whalers were using permafrost pits along the Canadian Arctic coasts to deep-freeze their whale meat. These pits were excavated in soils with little ice and then insulated with a cover of organic material such as peat or moss. Properly insulated, the pits would keep their contents frozen indefinitely. In the Klondike gold rush of 1896 prospectors often had to thaw the ore before they could get it out of the ground.

Following World War I, interest in permafrost was renewed by the development of petroleum reserves at Norman Wells and the building of the Hudson Bay railroad from Winnipeg to Churchill, Man. In both instances, engineers soon learned that permafrost could not be overlooked. Thawing of the ice-rich soil and extreme frost heaving cracked floors and walls in the buildings at Norman Wells and twisted rail beds out of shape on the Hudson Bay line. As a result, new techniques were devised to combat the damaging effects of permafrost.

"With the arrival of World War II, little time was left for permafrost study," says Dr. Brown. "Much of the emergency construction in the North during that period had to be carried out on a rather hit and miss basis. The result was that projects, like airfields, were damaged by frost action and serious drainage problems."

In 1950, the National Research Council of Canada set up a permafrost section and

initiated an intensive study of Canada's permafrost region. The same year, studies were underway to determine the extent of permafrost and the best methods of dealing with it. Today, information about frozen soils is being exchanged through a network of government agencies and other organizations whose activities take them into Canada's northland. Information is also being exchanged between the National Research Council and agencies in the USSR. In Siberia, recently, an international conference was held at Yakutsk, a city on continuous permafrost.

In the 1960s oil exploration in Alaska and in Canada's Mackenzie Delta and Arctic Islands increased, creating a need for more roads and larger settlements.

As the size of structures grew, buried foundations became a necessary part of their design. Says Dr. Brown: "Prior to about 1960, most buildings were small and lightweight. They could tolerate the movement that accompanied the thawing of ice-rich soils. Structures were simply jacked level and then wedged with either wood or stone. People looked on it as nothing more than regular maintenance—that is, if they did it at all."

Today, a number of construction methods are used to build safely on permafrost. Of the techniques used, concrete and wood piles have emerged as the most popular. With this method, the structure is raised off the ground so that the space underneath allows cold air to circulate freely.

By comparison, some structures are built to sit right on the ground surface on wood mats or concrete slabs. In other instances, gravel foundations, up to four and five feet thick serve the same purpose.

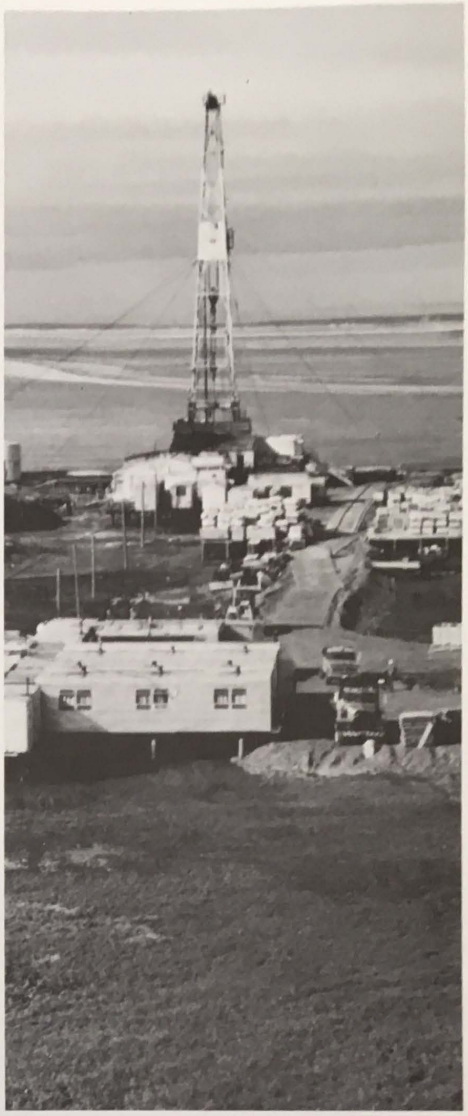
Sewer and water supply systems, in some large centres like Inuvik, are carried in above-ground, insulated boxes called utilidors. These protected corridors, sometimes buried if the soil is coarse and ice-free, protect the pipes from freezing and the permafrost from melting. Often, the two major services share space with such things as steam, gas, power and telephone lines. Utilidors are efficient, but they are so expensive that only large settlements can afford them. At places like Resolute, water comes in by tank truck; sewage goes out in plastic bags.

At its operating sites in the Mackenzie Delta and the Arctic Islands, Imperial is faced with all the problems that permafrost presents. "It affects everything the company does," says Alex Hemstock, director of environmental studies for Canadian Arctic Gas Study Limited (CAGSL). Hemstock, on loan to CAGSL since Jan. 1, 1973, was Imperial Oil's Arctic co-ordinator with the responsibility to ensure that company operations had a minimum effect on the tundra. "Imperial has made steady progress in learning to work harmoniously with the northern environment," he adds.

Imperial's drill rigs, according to Hemstock, are supported on wooden piles or on thick gravel pads if there is a danger of disturbing the permafrost. Around the rig, where trucks and tractors operate, additional gravel helps to protect the ground surface. The pilings and gravel at each of its drill sites cost Imperial some $300,000.

"But the main approach to protection of the tundra," says Hemstock, "is winter operations; then the ground is completely frozen. Ice and snow roads are built atop the frozen vegetation, leaving it undisturbed. The plows on bulldozers and graders are equipped with shoes so that blades do not gouge into the tundra. Vehicles travel on frozen lakes, rivers and coastal areas whenever they can, but even then, they are designed for reduced impact. Trucks are equipped with big tires that exert a low unit pressure on the ground and tracked vehicles are often used because their weight is distributed over a large area."

During the drilling operation the permafrost is continuously protected. For this purpose, one of the first pieces of equipment to reach the drill site is the refrigerator. Its coils are placed in the space between the inner and outer "strings" of casing, those lengths of pipe that drillers use to keep the drill hole from caving in. "And if the well becomes a producer," explains Hemstock, "the coils are left so that the oil, coming to the surface hot, will not melt the permafrost."



For drilling on permafrost, Imperial places rigs and buildings on piles or gravel pads.

But long before the drills begin to probe the tundra, the search for oil has been complicated by permafrost. Seismic readings produced by shock waves are often misleading through ice-rich permafrost. Dr. Brown explains: "The permafrost produces the same readings as solid rock and can confuse the seismic people if they're not aware it's below them. It's nothing but a nuisance."

In addition to its effects on seismic echoes and exploratory drilling, permafrost is one of the principal factors that would affect a gas pipeline from the North. Engineers plan to lick that one by joining it. By chilling the gas below freezing temperature, the line will keep the permafrost frozen. At 1,500 miles, it will be the biggest refrigerator ever built. ■

Working in the Arctic doesn't have to mar the landscape. Here's what Imperial does not to leave its mark.

stepping lightly

A strange set of values exists in the Arctic. Some of the most unexpected things are cause for excitement. For example, gravel causes quite a stir. In the high north, gravel is regarded as a semi-precious stone. It may not look like much, but it's invaluable as a means of protecting the region's natural environment.

At base camps and drill sites throughout the Arctic, Imperial uses gravel to protect the ground from damage by heavy machinery and to keep the permafrost from melting by providing insulation. But locating a good source of the scarce material does not always ensure a good supply.

Take the recent episode at Tuktoyaktuk. Imperial found gravel on the sea bed in Tuktoyaktuk Harbor, a finger of water extending inland from the Beaufort Sea. Not only was the gravel of good quality, it was also close to much of the drilling activity taking place in the Mackenzie Delta. But the gravel belonged to the town and the residents had to give their permission before any of it could be removed.

Fears that fishing would be disrupted in the salt water harbor were allayed when an aquatic study commissioned by Imperial showed that all the fish found there spawned in fresh water. Later, rights to the gravel were established when Imperial paid the people of Tuktoyaktuk with one half of 45,000 yards dredged from the harbor—enough to build five miles of roadway in the town.

During the three weeks that dredging was under way, the operation was watched closely by Tom Watmore, one of Imperial's two environmental officers in the North. Watmore, takes his job seriously and six years with the land and its people has made him sensitive to the North. He and fellow environmental officer John Cooper have the authority to stop any operation that violates accepted environmental standards. One of them is always on hand when any operation is under way, and sometimes both are there.

But disruptive operations seldom occur.

All phases of exploration, from rock sampling to clearing up at the drill site, are influenced by Watmore and Cooper before work ever begins. Work done for Imperial by independent contractors must also conform to the standards of the company.

Imperial Oil is exploring the Arctic's sedimentary basins seeking the additional energy that Canada will need when oil and gas production in the Prairies begins to decline. The search for new hydrocarbons is being carried out strictly within the limits imposed by federal and territorial government regulations.

In its range of activities, there is probably nothing Imperial does that reflects environmental awareness more than movement. Because it is easy to damage the surface of some areas of the tundra, Imperial restricts its land transportation over areas of ice-rich permafrost to winter, a practice the company followed even before federal regulations required it.

Some summer movement does take place at drill sites and base camps built on ice-rich permafrost, but only on thick gravel roads.

"We don't start active operations in areas where the permafrost holds a lot of ice until there is eight inches of snow and four inches of frost," says Watmore. "And even then, only vehicles with low-pressure tires can move."

Among its soft-stepping units Imperial counts the six-wheel-drive Kenworth truck, which was designed originally for work in loose desert sands. With tires better than five feet high and more than two feet wide, the truck's weight is distributed over a large area so that it doesn't make the ruts that trucks with smaller, thinner tires do. The desert truck, a favorite in the Arctic, is capable of pulling as many as three 16-ton sleighs, each of them holding 30 tons of cargo. These heavily loaded sleighs, equipped with three-foot-wide runners, slide easily over rough terrain and through snow drifts as deep as three feet. On cargo hauls where the snow is just too deep for the desert truck, Imperial brings out the tracked Foremost Husky Eight. This Arctic workhorse, while it lumbers along at a top speed of only five miles per hour, can itself carry 30 tons while pulling five 30-ton sleighs and a camp trailer.

The Flextrac Nodwell and the Foremost Delta Three, both wide-tracked vehicles, get most of their action with seismic parties. The seismic people send shock waves into the underlying rocks to test for geological structures that are likely to be traps for oil and gas. They must travel over uncharted tundra where no trails exist.

"Our goal," says Lloyd Hatlelid, Imperial's geophysical operations supervisor, "is to leave no traces. The less impact our vehicles make, the better."

Always tn the lookout for new and better vehicles, Imperial introduced the Caterpillar 824 into the fold in the winter of 1973-74. Instead of running on tracks like its predecessors, the 824 does its plowing on balloon tires that stand, at five feet six inches high, a foot taller than most automobiles. The advantage: it goes three times as fast as a vehicle on tracks.

Also last winter, Imperial began tests with hovercraft to determine possibilities for their use in the harsh Arctic climate.

"One of our troubles," John Cooper explains, "is that most equipment is de-

By Steve Lynett, Imperial Oil Review, *Number 2, 1974.*

Snow road system in the Mackenzie Delta (top right) helps to protect the tundra's insulating vegetation and costs about $6,500 per mile. Tracked vehicle (bottom right) with five 30-ton sleighs and a portable camp arrives at Tununuk base camp with a load of wood.

Portable incinerators are pulled by fast-moving seismic parties. Garbage that won't burn is buried in a 15-foot hole made by the seismic drill.

signed for southern conditions. We have to adapt it for northern use."

But significantly, the cheapest and the most easily obtained transporting vehicle is the ordinary highway truck with ordinary tires. The problem is what to drive it on. The ideal road is a frozen lake or river, but these surfaces are safe only from mid-January until early May. So, over land Imperial uses snow, and lots of it, a measure the company had taken before regulations made the construction of snow roads mandatory. During the course of a winter the company will build and maintain up to 250 miles of snow roadway in the Mackenzie Delta. Low-pressure vehicles start the snow roads by pulling a 'drag' made of logs or metal bars to pack the existing snow. Bulldozers with raised blades heap more snow on the packed surface until it is thick enough to perform its task. Special attachments resembling inverted mushrooms prevent the bulldozer's blade from digging into the tundra or scraping off the insulating cover of vegetation. The mushroom head slides on the snow keeping the blade elevated.

Three years ago Imperial tried building a snow road with a top layer of ice for added stability. "But that was impossibly expensive," says John Cooper. "It was very little better from an environmental standpoint, and hauling that much water pushed the cost up to something like $17,000 per mile. A good snow road will cost only around $6,500 per mile."

The winter road network ensures that equipment and supplies can move freely from the central base camps—at Tununu Point and Tuktoyaktuk—to the scattere drill sites in the Mackenzie Delta. (Arcti Islands supplies are moved by plane fro a major supply depot to each of the sca tered rigs.) Cleared regularly of constantl drifting snow, the roads permit movemer of any type of vehicle.

At the base camps, where supplies ar first collected for the drill sites, the groun surface is protected with gravel and woo chips. Most of Imperial's gravel come from the YaYa Lake region, 60 miles north west of Inuvik: logs are cut in the Aklavi area and moved to the drill site where the are cut and shredded by contract employ ees using a chipping machine.

Since Imperial has both winter an summer drilling programs, the methods o tundra insulation vary—obviously, mor and better insulation is needed in summe Imperial foremen select a combination o

A shredding machine stockpiles wood chips to be used as insulation at base camps and drill sites in the delta.

wood chips, gravel, plastic foam and wood pilings based on the needs of the well site.

"Plastic foam is used around the rig at practically every drill site," Cooper explains. "A lot of heat is produced by the rig and plastic foam has excellent insulating qualities. Gravel is spread on top of the foam and around the rest of the site for the machines to work on. The thickness of the gravel will vary from about one to five feet depending on the time of year."

And says Cooper: "Supplying the gravel is quite a chore when you consider that some of the rigs are as far as 55 miles away from the source."

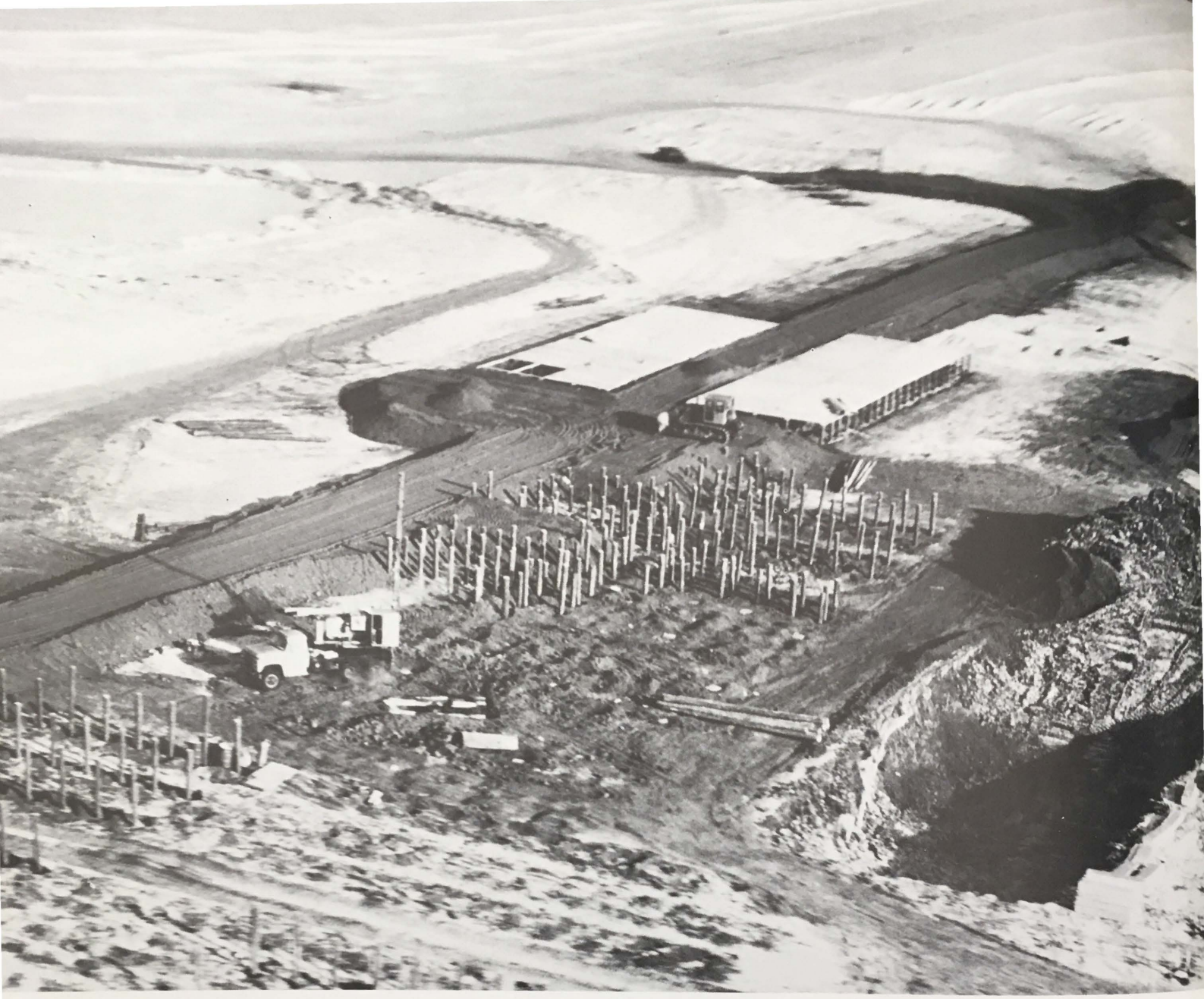
As a precaution in case of flooding on the table-flat delta and also as a means of protecting the permafrost, camp trailers and most supplies are stored on elevated racks. Even the rig itself is elevated. To accomplish this Imperial may use thick pads of gravel, but more often the company brings in 25-foot logs from the forests of the Mackenzie Valley. These logs, called pilings, are set in holes drilled in the frozen ground. This kind of site preparation—insulation and pilings—can cost Imperial as much as $300,000 at each well.

Close inspection would reveal that an Arctic rig differs from its southern counterpart. It is a heavier piece of equipment and its motors and pumps are larger. And due to more elaborate safety devices, the rig is raised some 14 feet higher.

As drilling proceeds, there is always the possibility that pockets of high-pressure oil and gas will be encountered. To ensure that nothing escapes at the ground surface, "blowout preventers" are fixed at the mouth of the bore hole. In Alberta these preventers are housed in a cellar beneath the rig floor. In the Arctic the equipment is not only larger but it must be kept above ground to avoid melting the frozen soil.

And beneath the safety equipment, there is another apparatus that is constantly at work keeping the permafrost intact. Drillers call it the refrigerator. Its task is to remove the heat produced in the wellbore. The refrigerator is a series of coils, placed in the space between the inner and outer "strings" of conductor casing—the length of pipe that lines the drill hole to keep it from caving in. If the well is a producer, similar coils could be placed so that hot liquids coming to the surface would not melt the permafrost.

Any place where 40 men live and work will have garbage, and a drill rig in the Arctic is no exception. But at Imperial



Drill site preparation: gravel, wood chips, plastic foam protect and insulate the tundra; pilings to elevate rig and camp.

sites, the waste isn't allowed to interfere with the natural environment. At the company's drill sites in the Arctic, a kitchen pit gets all the toilet, bathhouse and kitchen wastes while refuse from the drilling operation is collected in a sump. An oil-fired incinerator burns all the combustible garbage, and items such as tin cans go into the kitchen pit. Large pieces of junk such as worn-out engines and broken bulldozer tracks are returned to a central depot for disposal—usually at a clean landfill area.

On a fast-moving seismic party, waste is handled in a slightly modified way. Garbage is still burned in a portable incinerator but material that won't ignite is dumped in a 15-foot-deep hole made by the seismic drill. Everything that can't be burned or buried is carried with the party until it reaches a base camp. Says Lloyd Hatlelid: "These guys in seismic work are so environment-conscious that they won't even throw away a gum wrapper."

When a seismic party breaks camp, cleanup is quick in comparison to what must be done at the drill site. After the rig has been dismantled and moved to another location the site is restored as much as possible to its original condition. Usually the cleanup is done in winter. Says Tom Watmore: "We use bulldozers, so the ground must be frozen. Otherwise the machines would be wallowing in mud."

Both kitchen pit and drill sump are back-filled with the earth that was removed to form them and the frozen material in the pits becomes part of the permafrost. The gravel at the site may be "harvested" to be used again at another location or it may be spread about and mixed in with the soil. Pilings originally used to support the rig and its camp are cut off at ground level and either burned, buried or hauled away. (Pilings may be left for a time if the site is still being used for equipment stockpiling or temporary campsites.) Plastic foam, if it's used, is buried in the large sump. At this point the cleanup crew leaves—only to return again with the coming summer. Arriving by helicopter they take a last look for things that were buried under snow and missed.

Does the cleaned-up site look bad? Says Watmore: "Eventually the vegetation returns to its original state. After that you've got to look very hard to find the spot where drilling took place."

Protecting and preserving the region's natural environment as much as possible

Where roads don't exist, low-impact machinery is used to avoid tundra disturbance. Wide runners distribute weight over large area.

has been Imperial's practice since the mid-1960's when it began operations in the Arctic. Recently the company opened a new chapter in the search for Arctic hydrocarbons by drilling offshore in the Beaufort Sea. It is there that the greatest volume of the area's sedimentary rock is located and where there are prospects for major discoveries. This expanded activity has created a new arena for environmental protection. Drilling started in fall, 1973, at Imperial's Immerk B-48 well on a man-made island dredged from the floor of the Beaufort Sea. And just 19 miles away is the company's second artificial island, where a well drilled early in 1974 is being evaluated.

Unlike land-based rigs, where there is ample space for kitchen pit and sump, the island rig has only a limited working area. Garbage from the island site is hauled to shore to be burned or buried; sewage is treated on the spot in portable plants installed on barges.

The portable plants are the first to be tried by industry that far north. Tom Wattmore says: "They're superior to any treatment facility found in any Arctic settlement. They're the equivalent of secondary treatment facilities and they remove 85 to 90 percent of the bacteria from the waste material." In comparison, Edmonton's secondary treatment units, with the benefit of a much warmer climate, remove around 90 percent of the bacteria.

Besides preservation of the land and waters of the Arctic, Imperial personnel and all contract employees are made aware constantly of the need to protect the region's bird, fish and animal populations. With the guidance of the Canadian Wildlife Service, operations in both winter and summer are scheduled to avoid interference with such events as bird migration and nesting and caribou calving.

And in the waters of the Beaufort Sea, dynamite is no longer used for seismic operations. Instead special "air guns" are employed to avoid harming the marine life. A blend of oxygen and propane is ignited in a rubber tube releasing only acoustical energy into the water: with dynamite, as much as 85 percent of the energy is taken up in agitating the water.

Says Lloyd Hatlelid: "I've never seen fish killed by air guns—or sleeve exploders as we call them. I suppose if a fish had his nose right up against one, something might happen. Otherwise they're the safest thing we've got." ■

the mission possible man

Although he had been away from farm machinery for a good spell, Art Joens furrowed his native soil, a small farm outside Manilla, Iowa, expertly along contours suggested by nature. In the process, he and his two helpers gentled the earth to form a pond, a ho-hum place where bass and catfish now thrive.

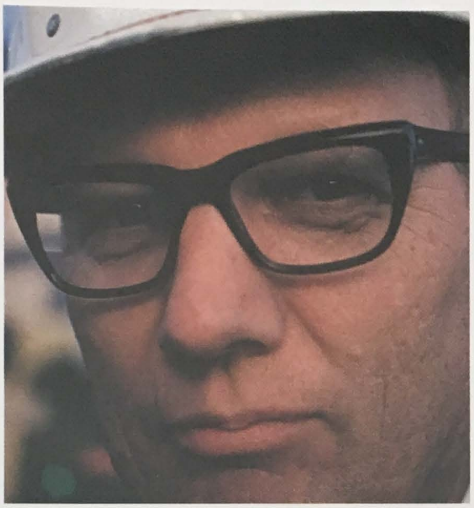
The fish thrive in some jeopardy, actually, because the children of neighbors now fish in the appropriately named "Pollywog Pond." They swim and splash it, too, for a sandy beach and diving raft have been added. The water supply, product of an age-old spring, is constant and pure. Terraces above the site preserve adjoining cornfields from erosion. The setting has been landscaped with native wildflowers, including some plantings that are intentionally for the birds: Joens' pond is a game sanctuary, too.

Inspired by Art Joens' example, several nearby farmers are now developing similar land and water conservation projects of their own. Joens, a vacation farmer only, bought his parents' farm on their retirement several years ago. For 22 years, Joens has worked for Exxon Company, U.S.A.

A professional conservationist finds that Oilman Art Joens is practicing conservation on the West Coast, too. "Art is a functioning conservationist," says George L. Collins, vice president of Conservation Associates, a consulting organization of San Francisco. "He is a rare bird. May his flock increase."

As Environmental Conservation Manager of Exxon USA's sprawling Western Division, Art Joens presides over a region in which the company's energy production hopes are bright, its commitments extensive, and its ecological challenges critical and sensitive. For the Western Division includes both the offshore Pacific and the Alaskan Arctic. It is an area of exceptional economic promise, but one where concern for the quality of the environment is high. It is Art's job to see that the former is not realized at the expense of the latter. When

By Keith Elliott, Humble Way, *First Quarter 1971.*



Art Joens is Environmental Conservation Manager for Exxon's Western Division.

he was given this responsibility, Art received some straightforward direction from Mike Wright, the company's Board Chairman. "Our specialists will locate and produce the energy," Wright said, "but our Environmental Conservation Manager must make sure they do their job without harming the environment."

Along with this responsibility, Art Joens received authority...the power to halt any Exxon job that is, in his judgment, a threat or potential threat to the environment. "He is not to be concerned with costs, efficiency, considerations of profit, or corporate ramifications of such a judgment," says Wright. "He is not to be a figurehead. He is where the buck stops."

Says Conservationist Collins: "As far as I know, Art's role is unique. Sure, every company has people who *talk* about ecology these days. There's nothing wrong with that. But it often seems to be lip service, and not enough seem to *do* anything about it. Exxon did. And in giving Art Joens authority to get things done, his company has shown admirable understanding of its responsibility and very practical foresight in conservation."

There is meaning in such praise from George Collins, for his own credits as an environmental steward are superb. He retired 10 years ago after 33 years with the National Park Service where he served in many assignments, including construction foreman, ranger, park superintendent, regional officer, and administrator of long-range planning. He contributed his efforts to many park projects that draw millions of grateful visitors.

Happily, the career continues in his work with Conservation Associates. That is a troika comprising himself and two lifelong working conservationist companions—Mrs. Dorothy Varian and Mrs. Doris Leonard. Their streamlined, self-financed team, together with a blue-ribbon group of advisors including Richard Leonard, attorney, and members of the Varian Foundation, gave to the people the Castle Rock State Park, a privately inspired project to save magnificent Pacific coastal mountain country. With underwriting and persuasion, the group has been notably successful in assisting through what Mrs. Leonard terms, "our concern for certain special places that were being overlooked and might have been lost in the backwash of bureaucratic indifference." Among them: California's Point Reyes National Seashore, Big Basin Redwoods State Park, San Luis National Waterfowl Refuge, the Farralon Islands National Bird Refuge, and more generally, projects ranging from the coastal Pacific to the great Arctic, Canada to Puerto Rico, East Africa, and Thailand.

In achieving such objectives, the leaders of Conservation Associates have found in Art Joens a colleague. "He is on the right side," Mrs. Leonard says, "assuming, of course, we are right, and it's hard to know who is teaching whom. Art has become an authority on Alaska and the Arctic. He has been immensely helpful up there, and in other regions as well where we are involved. He senses what society needs to accomplish in conservation to help do the job better. He has a rare combination of empathy and good judgment."

Exxon's "advocate for the environment," as a fellow employee describes him, has more than authority going for him. His effectiveness rests on a background that

commands the respect of his co-workers. Having worked as a roughneck, roustabout, engineer, and superintendent, Joens speaks the language of oil. W. P. Turner, a senior drilling superintendent for Exxon on the Santa Fe Drilling Co. floating drilling vessel, *Blue Water II*, in the Santa Barbara Channel, recognizes that Joens "knows the oil business inside and out. When he says something is possible, you just know it's possible."

On board the *Wodeco IV*, Exxon's other contract floating vessel in the Channel, a landlubber observed, "I thought oil rigs were supposed to be unkempt and greasy. This place is immaculate."

"It had better be, mister, or Art Joens would be on my back like a duck on a June bug," responds Exxon Drilling Superintendent Loren Meek, whose drawl is manifestly Texan. Meek counts himself a conservationist without portfolio. "You know, I like to hunt and fish. I sure don't want to spoil the environment." And he adds, "There's nothing skin deep about what you see here, either. We're near 800 feet below, too."

At the drop of a hard hat, Meek will conduct you on a tour of his rig. Proud as any skipper, he will point out a confusion of impressive equipment—underwater TV scanners, blowout prevention devices of unbelievable size and efficiency, drilling mud monitors (both mechanical and human), and dozens of other items one would associate with good housekeeping on a ship, a rig, or for that matter, a home. "Art likes things neat and orderly," says Meek, "and so do the rest of us. After all, most of the time, this is our home." Meek points to a sign, one of many about his ship, that seems to wrap up an attitude instilled by Exxon and Joens and executed in the field by men like Meek and Turner. The sign's no-nonsense dictum reads: "No POLLUTION."

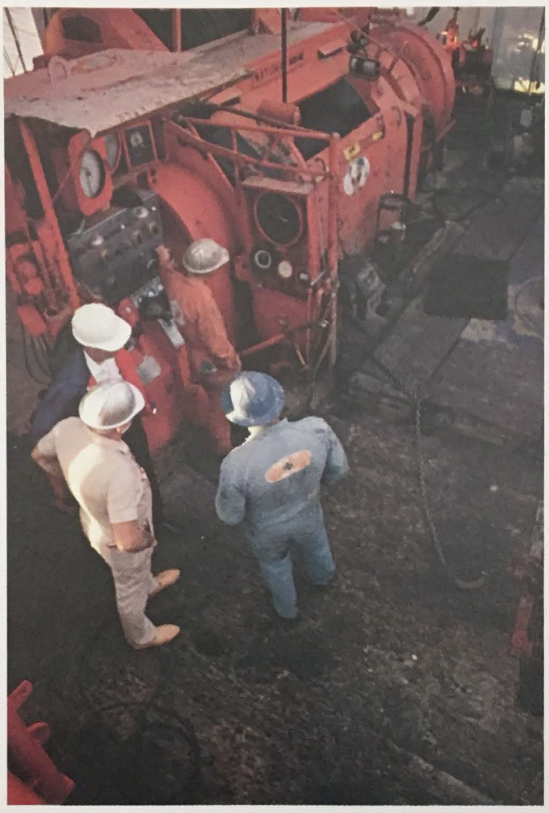
On these offshore rigs a visitor can see in practice the three principles that, in Art Joens' view, represent an enlightened policy at the operating level for protecting the environment. First, Joens believes that the men doing the work must be aware of their

At left, the Joens family in their natural habitat—out-of-doors. Joens (upper right), checks safety features in the control room of the Wodeco IV. Dr. Larry Tiezen with Joens (lower right), examines eroded tundra near Barrow, Alaska.

obligations to the environment. He points out that much, if not most, pollution can be traced simply to individual carelessness, which in turn is a matter of attitude. "These crews are so well trained in this area and so competent as a team, that the company spent more than a million dollars to keep them together when drilling was shut down for six weeks back in 1969," says Joens. Next in importance is equipment, especially back-up and fail-safe equipment possessing what the space men call "redundancy"—the industrial equivalent of wearing both belt and suspenders to keep your pants up," Joens laughs. "We have the best that money can buy," he says, "and we take great pains to keep it in tip-top working order."

Thoughtfully, Joens pauses before taking up the third item in his operating environmental policy summation. "I call it the 'what if?' factor," he says. "Despite fine equipment, superb technology, and experienced, concerned men—despite all this—*what if* there should be a mishap?" Joens explains that much of his time goes toward developing and implementing contingency plans for any eventuality, however remote, that might result in harm to any environment in which Exxon is operating. "People trained to respond promptly and correctly to emergencies," he says, "simply are better able to conserve than those who haven't prepared themselves."

Joens has pleasant memories of family picnics on the bank of a river running through an East Texas oilfield during his earlier days as an oilman. He recalls, "I remember deer playing and browsing alongside producing wells—and now I often see caribou doing the same thing in Alaska. There's nothing that says nature



Dr. Larry Tiezen, Joens, and Jim Hammond, director of Exxon's industrial hygiene staff (upper left), discuss Tundra Biome Research project at Barrow. Joens talks conservation (lower left), with Wodeco IV drilling superintendent Loren Meeks, and with crewmen at right.

and technology can't abide side by side, if we do our job right."

Exxon, Joens believes, has always tried to do the job right. One of his first engineering assignments (he has degrees in civil and industrial engineering from Georgia Tech) was a practical exercise in "environmental conservation," he says, "long before the term became popular."

His assignment was to design a facility for the safe disposal of salt water in a Gulf Coast operation, Joens remembers. He says, "It was just the first of many assignments that reflect Exxon's attitude that recovery of the energy and preservation of the environment are co-equal parts of the problem. So what I'm doing now doesn't represent a new philosophy. It only represents a response, within an old philosophy, to new problems and challenges."

The old philosophy has been challenged anew in Alaska, for example. Here, Joens uses diplomatic skill and engineering savvy in working with University of Alaska officials and others toward solution of health and sanitation problems faced by oil workers on the North Slope. "As we solve these problems," Joens points out, "we'll be solving traditional problems of the native population, as well."

A case in point: Joens and his associates are working to develop sewerage systems for Arctic oil drilling operations. Subfreezing temperatures will necessitate revolutionary techniques, but Joens is confident of success. And he adds pointedly, "What we develop will be of immense value to the residents of villages and some small towns whose sewerage systems now are unbelievably primitive—they collect it in barrels that are hauled to the outlying tundra where they stand indefinitely." In other words, Exxon's efforts to find solutions to pollution problems should produce direct benefit to Alaskans.

Joens' farming background has been helpful, he feels, in dealing with Alaska problems. For instance, at his suggestion, facilities on the North Slope incorporate a design akin to the terracing he employed back in Iowa to prevent soil runoff. He is also involved in an experimental seeding program aimed at restoring tundra that might be damaged by heavy equipment.

In tireless pursuit of facts, Joens has spent many hours with naturalists learning about the habits and migratory patterns of such dramatic wildlife species as the caribou and the anadromous fishes. Recently he journeyed to remote Prince William Sound to talk with fishermen and get their insight into the spawning eccentricities of salmon. "We're doing our homework in advance," Joens explains. "We want to be sure that we do nothing to upset the delicate balance of nature."

In pursuit of this goal, Art Joens has read widely and, as Conservationist Collins has noted, "he has listened widely, too." Joens likes to quote Harvey Wheeler, who, writing on "The Politics of Ecology," in *Saturday Review*, observed, "It is imperative to corrrect one common fallacy—one especially popular among the young. Technology is not the culprit."

Nevertheless, the writer points out, "misuse of technology is part of the problem." And Joens responds, "That's the part of the problem that is my responsibility—to see that my company's technology is not misused."

Whether he is observing new test vehicles that he hopes will move harmlessly over fragile Arctic tundra, or designing a special shield to catch tiny amounts of lubricant that might drip from an offshore rig, or rapping with students at the University of Alaska about *their* environmental obligations, or sending out field crews to collect any trash they see on the tundra or on the Arctic Ocean ice, Art Joens' mission for Exxon is clear: *"No Pollution."*

With quiet confidence, Art Joens says, "I call it our Mission Possible in action."

Santa Barbara alive and well

Robert Cimberg

What in creation was Catholic Sister Damian Marie Juge doing, month after month, cutting up little cakes of mud?

Why did Biologist Dr. Burney J. Le Boeuf invade uninhabited islands and wrestle sea lions?

If Dr. Nancy Nicholson could win a bathing beauty contest why did she don a mask and dive to the bottom of the ocean?

Consider Robert Cimberg, graduate student with a tendency toward warm coeds and cold beer. Why did he spend long lonely weekends of sun and storm, wading Pacific tide pools?

And why was Dr. Ronald L. Kolpack, quiet and reserved professor of geology, casting 15,000 self-addressed postcards onto the surface of the sea?

In diverse ways, each was seeking the truth—or truth's closest approximation. They were members of a 40-scientist task force that recently completed an 18-month study of the environmental effects of the Santa Barbara oil spill of 1969.

For citizens expecting the worst, the major scientific finding was a surprise: *the spill apparently caused relatively little biological damage, and nature quickly is healing what damage was done.*

These results are not easily accepted by many Americans. Millions had judged the Santa Barbara spill to be an ecological disaster of first magnitude. Understandably so; from what they saw, heard and read, they assumed the Santa Barbara Channel might become a "marine desert" and

By Don Dedera, Humble Way, *Third Quarter 1971.*

Dr. Ronald L. Kolpack

"dead sea" forevermore. Press coverage of the spill was intense. Stories told of numerous stranded whales, oil-suffocated seals "as far as the eye could see," a devastated fishery, and tidal zones and beaches hopelessly stripped of life. Not even a five-million-dollar cleanup was given much credit for restoration of the coast. Santa Barbara became the battle cry of the Age of Ecology.

"I was horrified by the news, along with everybody else," said Dr. Dale Straughan. "But being a scientist, my next thought was, 'What really happened? What will be the aftermath? What can we learn?'"

The opportunity for science to seek the answers came from a most logical source, the oil industry. While the oil was still on the water, Western Oil & Gas Association provided $240,000 in a no-strings-attached grant to the Allan Hancock Foundation at the University of Southern California. Dating back 60 years, the Hancock foundation has administered impartial academic research to the earth's polar waters and all the seas between.

The foundation accepted the oil grant with firm understandings that the study would begin immediately, that the oil industry would exercise no influence, and that the findings would be published. Guidance for the study was charged to a committee of federal, state and private natural scientists.

To direct the study project, Foundation Director Dr. Bernard Abbott chose Dr. Dale Straughan, that scientist whose initial concern had turned to keen curiosity. A handsome, pert Australian just turned 30, Dr. Straughan (pronounced "Strawn") was visiting USC on a postdoctoral fellowship. She had specialized in marine biology at the University of Queensland on the Great Barrier Reef, and in Hawaii and Costa Rica. In Australia she had made a name for herself as a consultant in marine biology. To complement her credits in biology, Dr. Straughan had an abundance of enthusiasm, candor and fierce Australian independence.

With time a critical factor, Dr. Straughan accepted help from scientists already hard at work in the channel. She sought further assistance from government agencies, from private investigators, from colleagues of other universities.

"At the time of the spill we were on the Channel Islands, tagging seals in an entirely different project," recalled Dr. Le Boeuf of University of California's Santa Cruz campus. "So it was rather routine for us to set up some mortality studies on marine mammals." Dr. Le Boeuf tagged test groups of oil-stained and oil-free young elephant seals for future observation. Fifteen months later Dr. Le Boeuf concluded that "the crude oil which coated many weaned elephant seals at San Miguel Island in March and April, 1969, had no significant nor long-term deleterious effect on their health."

Concurrent experiments on California sea lions (circus seals) were done by Dr. Le Boeuf and Robert L. Brownell, Jr., of the Department of Pathology of John Hopkins University. They found that oil did not substantially increase death rates of sea lion pups, whose infant mortality from many causes is notoriously high. Summing up, the scientists deplored magazine reportage that "was emotional and impressionistic and included statements which implied conclusions not based on fact."

In an interview later, Dr. Le Boeuf said, "Both Brownell and I deeply resented the 'quickie' trips of laymen and their sensational rumors. We're the kind of guys who crash down on top of an unpopulated island and in the interest of preserving a species, we stalk seals on our hands and knees through the surf, and get bitten and scratched for our trouble, or freeze for hours in a blind, and maybe live outdoors for a month, and stay up to midnight adding up the results... and then people who confuse sleeping seals with dead seals make one pass with a boat, and go back to the mainland with disaster stories."

Brownell also looked into strandings of whales and dolphins before, during and after the spill. He wrote, "The number of gray whale strandings in 1969 does not differ significantly from that of previous years." Also, "The one dolphin reported was said to have died from a massive lung hemorrhage caused by its blowhole being clogged with oil, but there is no evidence to support this statement."

Again and again, the props for a "dead sea" theory collapsed under scrutiny of the

Dr Nancy Nicholson

project scientists. They had access to Hancock's splendid marine library and specimen collections, oceanographic vessels, and the new Catalina Marine Science Center. The scientists, from a dozen disciplines, considered every aspect of the channel ecology the budget would allow. Many worked without pay. In the process, they demonstrated anew the variety of people drawn to oceanography.

Sister Damian Marie, a microbiologist teaching at Immaculate Heart College in Los Angeles, prior to the spill had been studying microscopic organisms of the channel bottom for her doctoral dissertation. For the Hancock project, she extended and elaborated on her analyses of channel bacteria.

Dr. Ronald L. Kolpack, a seagoing geologist, authored four papers dealing with physical, chemical and geological characteristics of the channel and had served as chief scientist on oceanographic cruises to the North Atlantic and Antarctica.

(In one of his imaginative Santa Barbara inquiries Dr. Kolpack learned as much about human nature as ocean currents. Of 15,000 plastic-wrapped drift cards released in the channel, some 1,800 were returned by helpful finders, many of whom could not resist filling in a blank space for "remarks." Mailed from Oregon and Mexico and everywhere between, remarks ranged from "Peace, brother, peace," to "Don't be a litterbug," to "Happy Valentine's Day, I love you.")

Heading surveys of intertidal life was Dr. Nancy Lynne Nicholson, noted (beyond her specialty in marine algae) for forthrightly speaking her mind. She praised graduate students who worked long hours at little or no compensation.

"Surveying the intertidal zones is cold, wet and miserable, day and night, rain or shine, Sundays and holidays. Low tide doesn't take into consideration the ideal hours for human beings." A certified scuba and skin diver, Dr. Nicholson herself joined in much of the intertidal field work.

Others in the Hancock team were a pollution ecologist, a distinguished lecturer on submarine sediments, a former Yellowstone park ranger, and a Norwegian expert on invertebrates. With such talent, Dr. Straughan chose an administrative structure that provided her co-workers with the greatest possible freedom. Independently, each wrote his own paper.

"The findings stand on their own merit," said Dr. Straughan, "with each author taking responsibility for his own research results and interpretations." When published with National Sea Grant financing in Spring 1971, the reports totaled 900 pages in two volumes, "Biological and Oceanographical Survey of the Santa Barbara Oil Spill."

Far from being a marine desert, the channel following the spill was found to be teeming with life. Over-all damage by the spill was much less than feared. Where damage could be documented, nature was returning to normal.

Factors generally overlooked by non-scientists:

For centuries crude oil has been an influence on channel life systems. Natural seeps off Coal Oil Point leak oil totaling 11 to 160 barrels a day. Certain marine species seem to be oil-tolerant.

In winter, at the time of the spill, marine life normally is at an ebb on some beaches, a seasonal cycle unrelated to pollution.

Heavy rains producing the biggest floods to hit Southern California in 40 years occurred during the time of the oil accident, placing sea life under stress from fresh water runoff, storm debris, sediments, and pesticides. Isolating effects of oil pollution from these stresses was very difficult.

Dr. Straughan compiled the biological studies into Volume I of the Hancock publication. In simplest terms, the study found:

No ill effects on either animal or plant plankton.

The volume of benthic (or bottom) biomass and its distribution did not much change between May and October 1969.

As reported by Le Boeuf and Brownell, mammal mortality was insignificant. Oil may have caused the deaths of some sea lion pups, but not in the exaggerated numbers mentioned in the press, and Brownell believes that DDT is a far greater killer by inducing premature births.

No damage from oil pollution could be found on sandy beaches. These findings, however, are inconclusive in that no

Sister Damian Marie Juge

baseline existed from former years.

A decrease in life was observed in oiled tide zones. But a general decrease in intertidal life was discerned as well on California shores that were not touched by oil. Dr. Straughan speculated upon some probable causes: "A general increase in pollution of many kinds and sources, and the impact of people, collecting and disrupting tide pool creatures."

The Santa Barbara Channel commercial fish catch was *greater* in the six months *following* the oil spill, than in a comparable six months the year before. Only when fishing boats avoided the oil by remaining in harbor did the fish catch diminish.

Twelve thousand birds survived in the channel through the time of the spill, while 3,500 to 4,000 perished of all causes. By May, 1969, the population rose to 85,000 because of seasonal migration.

In Volume II edited by Dr. Kolpack, some important oceanographic conclusions were:

Only remnants of the oil remained buried on the beaches a year after the spill; much of the oil went to the channel bottom after mixing with flood sediments.

"Deposition of the oil on the beaches did not significantly alter the normal movements of beach sand. Tar globules which were removed from the foreshore area, as a result of seasonal cutting of the beaches, accumulated in the troughs just inshore of the wave breaker line. These tar globules were subjected to intense abrasion by the breaking waves and were physically broken down into small fragments within a period of, at most, weeks. The smaller fragments of tar were probably then transported offshore."

The most logical conclusion that can be drawn is that a combination of seasonal variations in both productivity and the intensity of beach processes, but not a kill-off by oil pollution, caused the changes observed in the beach foraminifers (one-celled organisms) of the Santa Barbara Channel region.

"Neither the total benthonic (bottom dwellers) or planktonic (floaters) populations showed significant changes in the vicinity of the well blowout during this investigation as compared to work completed prior to the well blowout."

In lengthy, thoughtful critique of her team's effort, Dr. Straughan stated, "Damage to the biota was not widespread, but was limited to several species ... the area is recovering well."

Outside critics of the project were quick to charge that (1) a shortage of comparison data made the findings meaningless (2) the study didn't go far enough and (3) that somehow 40 independently functioning scientists abandoned their professional ethics to produce a false report.

In response, Dr. Straughan said that to the contrary, the Allan Hancock scientists turned up a wealth of comparable studies back through the years. Dr. Straughan admitted they could have used more, yet, "The Southern California coast has been one of the most intensely studied coasts of the world. We were able to return to stations that had been surveyed only a year or two before the spill. We did have our limitations of money, of boat time, of people available on short notice. There are gaps. I'm somewhat critical of certain areas– but then, that's inevitable where people are working freely. For example, just because we could not pinpoint damage, it does not mean that absolutely no damage was caused by the spill. This word 'damage' is also difficult, and depends on how one views a situation."

She added, "I agree that the report is not yet complete. Both volumes refer to work still in progress. For example, extensive work on oil analysis using the modern technique of gas chromatography is still in progress and unpublished."

Those who have questioned the integrity of Hancock scientists quicken Dr. Straughan's Aussie temper, which includes a few household cuss words. "I don't know how to cope with that kind of attack," said she. "I tell things as I see them. I don't have to defend myself."

It has hurt her that some who disagree with the Hancock study have accused her of not caring about the environment.

"Of course I care about my environment," she said. "Part of the public conclusion is based on an erroneous assumption that all oil spills are the same. Yet a Santa Barbara is not a *Tampico Maru*, and a Falmouth is not a *Torrey Canyon*. It happens that Santa Barbara crude is a heavy

oil, relatively insoluble in water, and low in toxic fractions."

She continued, "It's obvious to me that one, single spill is sort of the last of our worries. Not that I mean oil pollution research is unimportant. Otherwise, I wouldn't be doing it. But it must be kept in perspective with other pollution—by chemicals, sewage, heavy metals, heat, pesticides, and radioactivity."

For all her preoccupation with pollution, Dr. Straughan doesn't live the subject 24 hours a day. No dissector of cats, at home she dotes upon a spoiled Siamese. She paints whimsical, life-worshipful oils of flowers and sea-stars in cool bold strokes. She is an accomplished chef. With her biologist husband, Dr. Ian Straughan, she shares a hobby of gardening.

Saddened by the Santa Barbara bird losses, Dr. Straughan invited three Santa Barbara women to submit a paper on first aid and convalescent treatment given the channel's oiled birds. Barbara Drinkwater, Maurine Leonard and Susan Black had been involved in the rescue. Publication of their detailed paper within the Hancock survey may promote their hope for "A knowledge of the best methods of handling these unfortunate birds" which would result "in a higher survival in many species, plus a better use of manpower, finance, and equipment."

In the center of controversy, the Allan Hancock report is not without admirers as well as critics.

"I visited with Dr. Straughan when the research was in progress in the channel," said Dr. Wheeler North, professor of environmental science at California Institute of Technology. (Caltech was not represented on the Hancock team.)

"I reviewed her program, observed the techniques. I thought it was a splendid organization."

Dr. North, widely known for his definitive study of the wreck of the oil tanker *Tampico Maru* on the Baja California coast, added:

"There is one unavoidable fact—all animals are reproducing now in the Santa Barbara area." ■

Dr. Dale Straughan

Dr. Burney J. Le Boeuf

harvesting food and fuel from the gulf

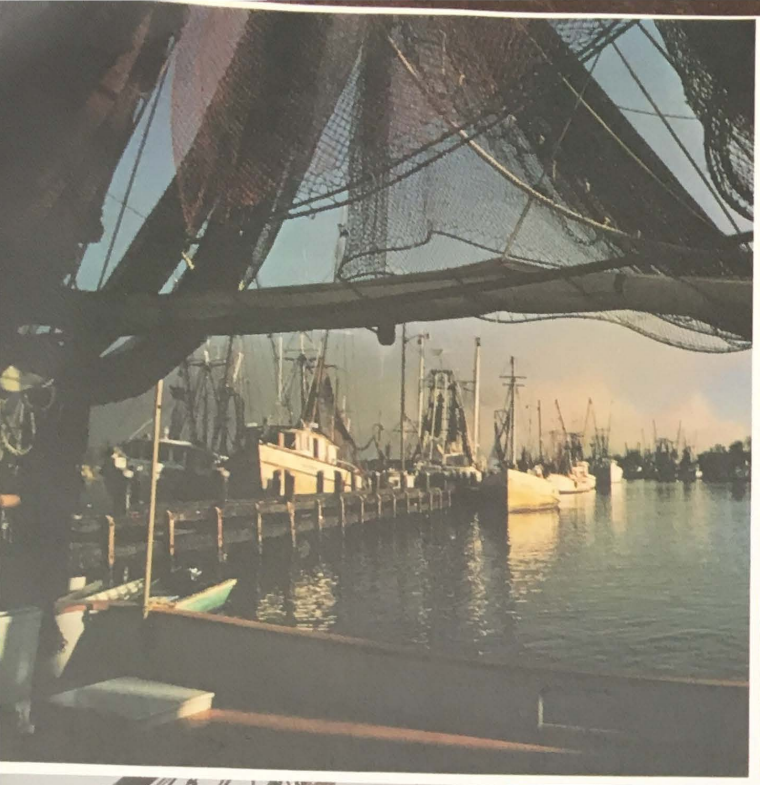
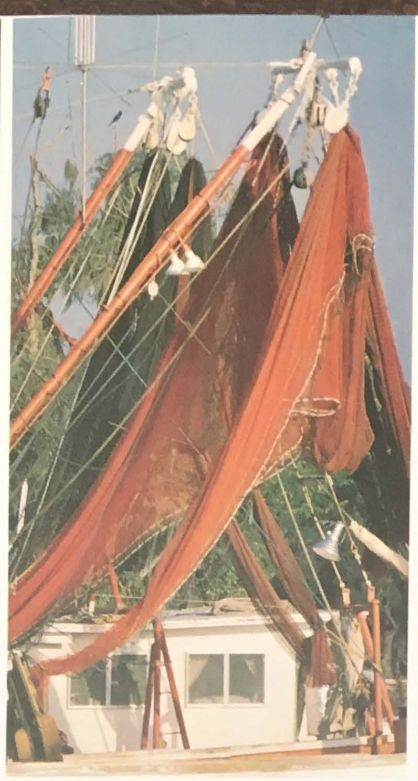
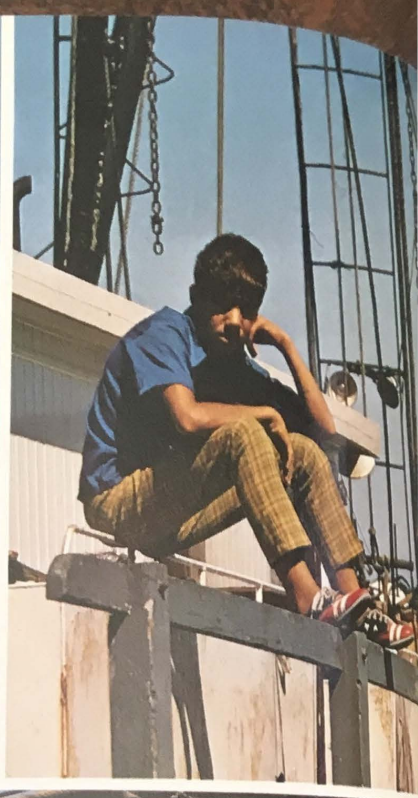
By Joseph E. Brown, Humble Way, *First Quarter 1972*

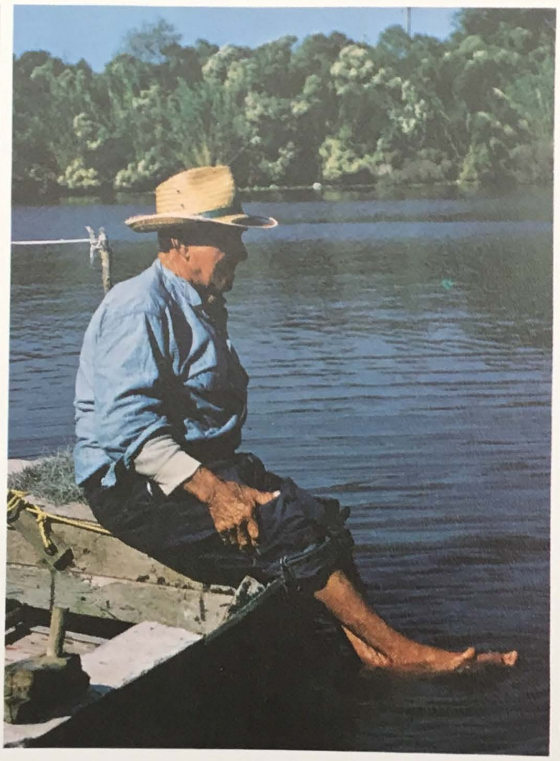
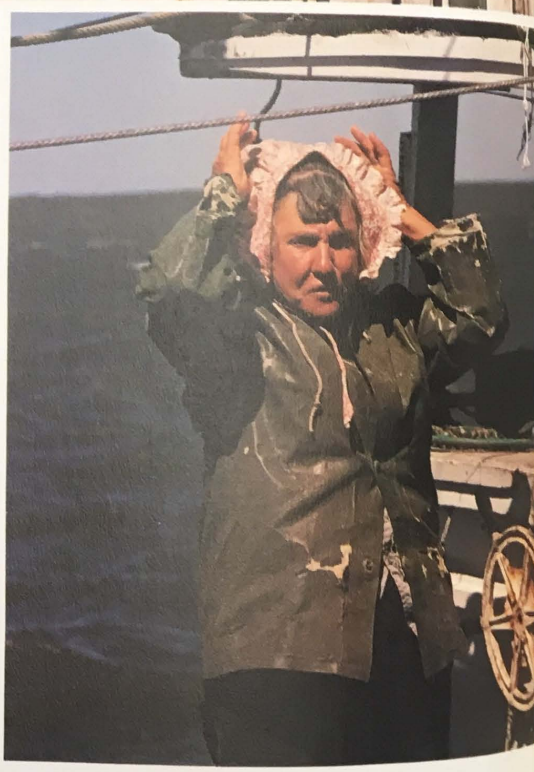
Dawn. A wispy fog persists, puddling in mini-droplets on water hyacinth fragments drifting downstream on Louisiana's Atchafalaya River. In the wheelhouse of the 83-foot, steel-hulled *Sea Harvester,* delayed by the weather at its dock in Morgan City, skipper Joe Webster peers through the gloom and scowls a rare scowl.

Since last night, the trawler has been ready for sea. Fifteen tons of ice jam her hold. Three thousand gallons of fresh water fill her tanks. Trawl nets dangle from twin booms. Stowed in her galley lockers are enough bacon, brownie mix, and rich Louisiana coffee ("Thick, so's a spoon can stand up in it.") to satisfy the ravenous appetites of Webster and his two crewmen for two weeks. Three, if fishing is slow.

The crewmen are Webster's 29-year-old son, David, and 18-year-old Steve Landry, recently returned from Marine Corps duty in Viet Nam.

Webster, fiftyish, relieves his irritation by busying himself with one of two paper-

back books in the wheelhouse, a collection of Billy Graham sermons. (The second, equally as dog-eared, is an anthology of essays on the Great Depression.)

As it always does, however, the warm morning sun soon burns the fog away. The *Sea Harvester,* engines rumbling contentedly, nudges cautiously into the Atchafalaya's brown current. Twenty-eight miles later, past what outbound mariners refer to simply as "the beacon," the working day will begin in the Gulf of Mexico.

Forty miles east, a mile below Golden Meadow, Larry Haynes, a spry and nimble 22, cranks up the engine on his skiff and merges with other southbound traffic on Bayou LaFourche. The skiff is a "day boat," one-sixth the size of the *Sea Harvester.* Soon, Haynes reaches an inlet leading east to a small bay. Gently, he eases the throttle back, checks to see if his brown-bagged lunch is still under the seat where he put it, and begins unwinding a small net. Larry, too, is ready for work.

At Barataria, south of New Orleans, Frank Kuhn, 29, inspects the latest repair work on his frequently patched trawl. He doesn't call it that, however; in the rich, colorful language of the Louisiana Cajun, it comes out *troll.*

Last trip to the Gulf, Kuhn remembers balefully, a school of frenzied sharks ripped the $800 net to shreds. A man with a girth any two pro football linemen would be proud of, he runs a thick, grease-stained hand over the stiff wire mesh he has jury-rigged to protect the nylon net, and smiles to himself.

Twenty minutes later, the cedar-planked, 60-foot *Southern Belle,* her chipped, fading hull low in the water with a two-week supply of fuel and provisions, pokes its way south along Goose Bayou, toward the Gulf.

Although Joe Webster, Larry Haynes,

For generations, Louisiana families have gone to sea in their sturdy craft in pursuit of the Gulf's bounty.

and Frank Kuhn have never met, they share a common bond. Frugal, fiercely independent, spending up to one-third of their lives at sea, undaunted by neither hurricanes nor the capricious migratory whims of their prey, they wrest their living from the Gulf of Mexico as shrimp fishermen.

Teamed with the oyster dredgers, the menhaden "pogy men," the seiners and other commercial fishermen, they are part of the giant Gulf Coast seafood industry which in 1970 poured a whopping $164 million into the Gulf economy. That represented 27 percent of the nation's total seafood harvest, more than that of Chesapeake Bay, the South Atlantic, and the states of Washington, Oregon, and Hawaii combined.

Bringing all that shrimp back means a tough, hard life, long weeks at sea away from home, a life of pitching decks and salt spray and scorching sun.

Each boat trawls an average of twice a day, perhaps five or six hours at a stretch, each of the 12 to 14 days it spends at sea. While the net is out, scooping its booty from the sea floor, crewmen sort and clean the previous batch of netted shrimp, pack them in ice, and return unwanted "trash fish" to the sea.

Louisiana trawlers collectively cover a distance over the Gulf floor each year equivalent to the circumference of the earth at the Equator—around 24,000 miles. And this doesn't include inshore skiff shrimpers such as Larry Haynes.

Shrimpers, however, usually aren't impressed by such statistics. "You can rattle off numbers all you want," drawls South Carolina-born Joe Webster, typically, "but all that really counts is today's catch, tomorrow's payoff at the unloading dock." The payoff may bring each man up to $1,500 as his share of the catch. Sometimes, more and sometimes, less.

It's a highly competitive business, Gulf shrimping. "Trouble with this work these days," says Webster, "is that everybody figures it's a way to make a quick buck easy." He points out that in 1969, in one year alone, 316 new boats joined the Gulf fleet. Some of the oldtimers, such as Webster, talked of moving to Australia where the ocean is less crowded. "But down there," he says, "they want an import duty on your boat equal to 40 percent of its value." With $90,000 tied up in the *Sea Harvester,* Webster and his partner decided to stay in the Gulf of Mexico.

As members of the Louisiana fleet, Webster and his brethren of the sea are heirs of a tradition dating back to 1755 when French settlers of Acadia in Nova Scotia were forced to leave by the English. Some Acadians found their way to Bayou Teche, where they began harvesting the rich tidal fishery in their distinctive flat-bottomed boats called *bateaux.* Until the 20th century, Louisiana fresh water fishing, preponderantly by "Cajuns," outranked the offshore catch in dollar value; the state's fishery as a whole trailed far behind those of other U.S. areas. But in 1917, the introduction of the trawl net brought change. Only two years later, the offshore catch overtook the freshwater industry and has outranked it ever since.

In the 1940's, however, another industry began taking an interest in the Gulf, one that would eventually dwarf fishing in its size and impact on Louisiana's economy. Oilmen, realizing that the state's oil and gas potential didn't stop at the shoreline, began exploratory drilling offshore. At first, wells were drilled in relatively shallow water. Exxon Company, U.S.A.'s multimillion-dollar Grand Isle A platform stood eight miles from the beach in only 40 feet of water. Impressive discoveries led to heightened interest, and during the 1950's offshore drilling boomed to awesome proportions. At various times, over a hundred drilling rigs probed the Gulf floor, and with developing technology, oilmen moved as far as 90 miles out to drill in over 350 feet of water. In time, around 10,000 wells would be drilled in the Gulf and some 2,000 producing platforms installed. The industry's offshore investment approaching $7 billion pumped new fiscal life into Louisiana's economy. Oil revenues, for example, presently finance 46 percent of the state's budget. "That means," a state legislator points out, "that oil pays for every second classroom, half of every highway, every second bed in every state hospital."

Sleepy coastal fishing villages began to hustle and bustle with newly arrived oil interests. For example, Morgan City, home port for a large shrimping fleet, became a major staging area for the offshore oil industry. Its annual two-day fais-do-do for the blessing of the fleet became the Shrimp and Petroleum Festival. With sister towns Berwick and Patterson, population soared to 36,500, nearly one third of whom work in petroleum or petroleum related activities, and who earn in excess of $125 million in salaries each year.

At the same time, Morgan City continued to be an important shrimp fishing port with a large population of fishermen who considered the Gulf their private lake. At first, shrimpers and oilmen seemed destined to lock horns. But this didn't happen. What evolved, not entirely without friction but without bloodshed, was a spirit of "live and let live" between the two industries. It continues to obtain today.

There were problems, of course, but the two industries worked them out.

Shrimpers, for example, sometimes ripped trawl nets on underwater pipes or "stubs" which federal regulations required oil companies to install on successful wells while preparing to erect producing platforms. In waters of less than 85 feet in depth, oil companies marked such stubs with buoys and their locations were noted on navigation charts.

"But when you're busy trawling," Kuhn explains, "you haven't got time to stay glued to a chart. So, we lost a few nets."

Learning of this, oilmen conferred with shrimpers and government officials. The outcome: a change in federal regulations to permit a lease to be held without leaving a re-enterable stub. This change in rules enabled the oil industry to cut down on the number of stubs, and to remove many stubs already in place. By summer of 1972, the Gulf will be largely free of stubs.

Another change in oil industry practice took place after fishermen objected to the discharge of dynamite at sea by seismographic survey teams. As an energy source, seismographers turned to newly developed electronic "pingers" and a device which explodes small amounts of natural gas inside an expanding rubber

A small try-net brings up shrimp, so the captain orders his big nylon trawls paid out from the Hustler's *twin booms.*

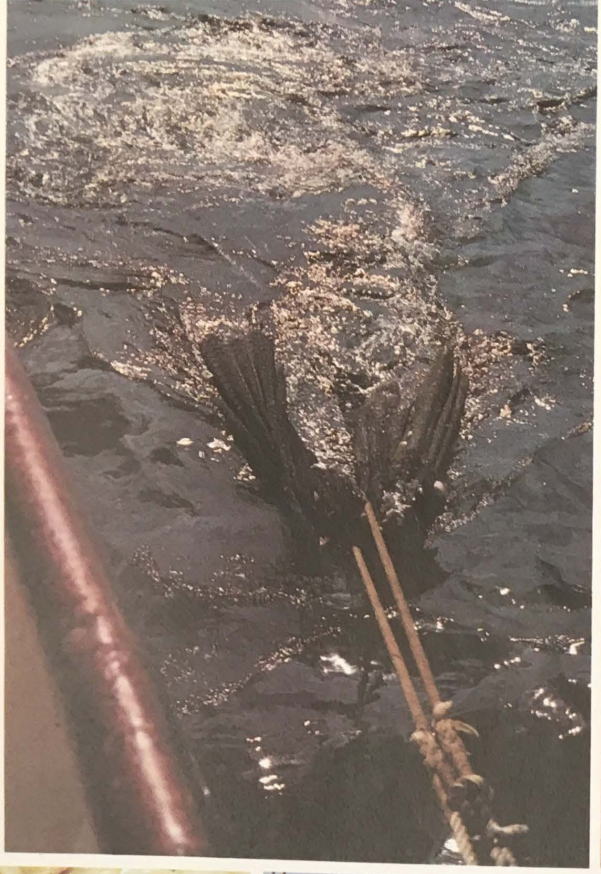
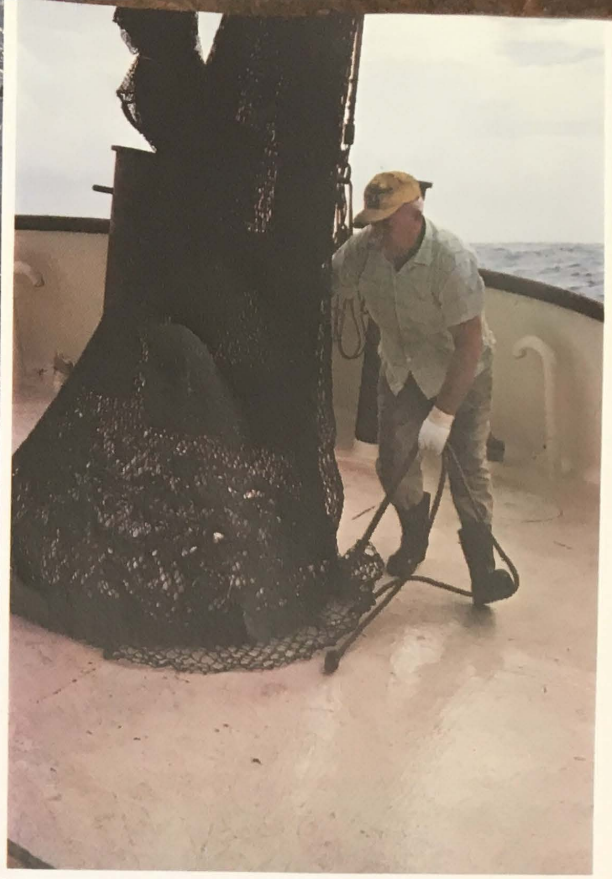
sleeve. In addition to being harmless to marine life, the new methods were found to give better results and more accurate maps of the subsurface.

Some fishermen fret about the acreage which offshore platforms remove from the Gulf fishery. But oilmen point out that platforms erected so far occupy only 378 of Louisiana's 18 million offshore acres. They also observe that this small loss is more than offset by the discovery that offshore structures become artificial reefs which attract fish and stimulate the production of marine life, as shrimpers have learned.

"The platforms," says David Webster aboard the *Sea Harvester,* "seem to provide a sort of haven for fish. We find more shrimp right around the rigs today than ever before."

Of current concern is the question of what effect routine oil operations (and other types of development as well) may be having on Louisiana's estuaries. Dr. Lyle St. Amant, assistant director of the Louisiana Wild Life and Fisheries Commission, stresses that the state has 7.3 million acres of marshes and estuaries, one fourth of the nation's total, which are biologically important. "This vast marine nursery is unique in the United States and perhaps in the world, one which generates more than one billion pounds of commercial fish annually," he told a convention of the Society of Petroleum Engineers recently. "When man's activities are imposed on this ecologically unstable area, the rate of breakdown becomes critical."

Oilmen share Dr. St. Amant's concern. J. R. Jackson, Exxon's manager of exploration environmental affairs, supports Dr. St. Amant's suggestion for a surveillance program to control canals and dredging. "I'm sure the industry will find a satisfactory solution, as it has with other problems," he adds.


Culling their catch, deckhands return unwanted fish to the sea and ice down shrimp in the hold for delivery ashore.

Dr. St. Amant believes that compatible use of the Gulf by shrimpers and oilmen should continue. "Because of the high productivity of both," he said recently, "it's apparent that every reasonable effort must be made to allow the two to operate in the same area without conflict."

Shrimpers agree. Says Frank Kuhn aboard the *Southern Belle*, "Oilmen and shrimpers need each other. I know that we need oil. I couldn't earn a dime out there in the Gulf if I didn't have fuel for my boat. And I did okay out there last trip." Kuhn also points out that fishermen find the platforms useful as navigational aids, and a welcome sight in times of distress.

After a quarter-century, it may still be too early to say whether or not oil has actually benefited shrimping. But statistics suggest, at least, that it hasn't harmed it. Gulf seafood production has kept pace with oil operations in climbing to record levels. Shrimp are only part of the success story. In a wide range of categories—redfish, flounder, and sea trout, for instance—Louisiana catches have increased markedly. Menhaden production has been phenomenal. Since the early 1940's when the first "pogy boat" arrived in the Gulf and began landing an average of 88 million pounds of fish a year, the annual take has zoomed to more than 1.3 billion pounds. And Louisiana is the only coastal area between Maine and Texas where oysters have held their own despite a general decline in production elsewhere.

"There's no reason why shrimpers and oilmen can't work together," says Nelson DeSoto of the Louisiana Shrimp Association. "Each needs to respect the other's rights. If oilmen damage our grounds, they're not welcome. If we harm their rigs, they're entitled to get sore. Personally, I think both industries are doing the right thing out there in the Gulf." ■

mother nature's oil wells

Oil bubbled to the surface of California's Santa Barbara Channel and spread into an ever-widening slick. Nudged by wind and current, it drifted shoreward. Soon, it coated rocks, sandy beaches and unwary seabirds with a midnight-colored smudge. A mile from shore, a ship's captain noted the slick. "As far as the eye can see," he jotted in his log, "the sea is covered with a sticky, smelly substance."

The year was 1793; the observer, an English explorer named Vancouver whose sailing ship was standing off a promontory later to be named Coal Oil Point because of the petroleum commonly found floating on the surface of the ocean there.

The oil Vancouver saw came from one of nature's oil wells. Geologists call them seeps, and say they've been leaking oil and gas into the environment for millions of years. There are hundreds, perhaps thousands, of them—no one knows for sure how many. They are found the world over, some on land, some, like the seep at Coal Oil Point, in the floor of the sea. Since time immemorial, men have collected the seepings of these oil springs, using the liquid to caulk boats, preserve wood, heal wounds, cure disease, start fires, embalm bodies, and cement stones.

Biblical scholars suggest that Noah used natural tar from oil seeps to caulk the seams of his ark. "Greek fire," the ultimate weapon of the Bronze Age, was actually petroleum skimmed from Middle Eastern waters. American Indians called the stuff "atouronton," and valued it as an all-purpose physic.

Explorers have been noting the presence of oil seeps for centuries, and often, their observations have led to the discovery of important oil reserves.

John Muir, a 19th century naturalist and writer, described many oil and gas seeps in the Gulf of Mexico in his classic work, "Geology of the Tampico Region." Later, geologists probing for oil in the Gulf consulted Muir's charts as a starting point in their exploration.

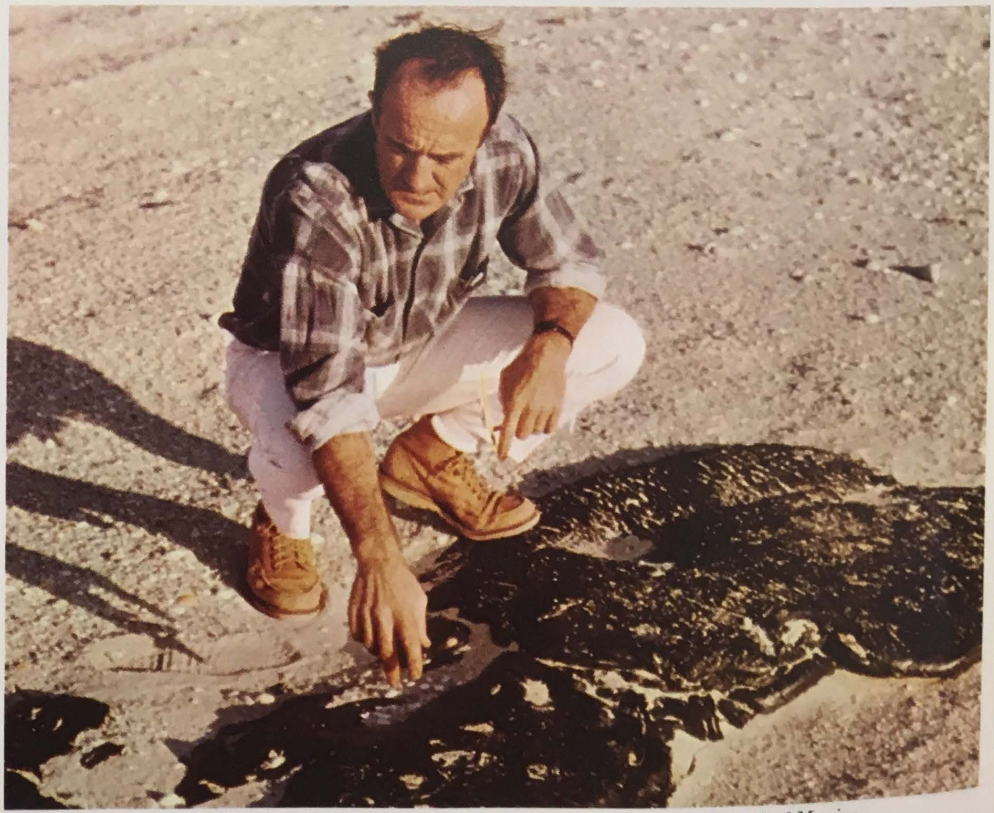
In the 1890's, a French geologist and archaeologist named de Morgan wrote of seeps in the oil-rich Middle East. Maps of Iran, are dotted with place names containing the words *naft* or *naftun,* meaning oil, and from which the word naphtha is derived. His work resulted in the first oil well drilled in the Middle East at a place called Maidan-Naftan.

On the western coast of Trinidad at the Gulf of Paria, there is a lake completely covered with asphalt. Local residents call it Pitch Lake. Not far away, at La Brea Point, a submarine spring 200 yards offshore yields brown oil and gas bubbles.

Oil seeps were noted in Alaska as early as 1896. A noted outdoorsman, hiking in the foothills near Katalla, reported smelling "a petroliferous odor, somewhat like kerosine." He saw oil and tar floating on a river. At the source, he found that "the entire area was covered with oil and a black asphalt residue."

By Joseph E. Brown, Humble Way, *Fourth Quarter 1972.*

Bubbles of oil and gas rise from a seep in the seafloor a mile off of Coal Oil Point.



Dr. William Sweet examines tar from a natural seep in the Gulf of Mexico.

As an obvious clue to the existence of nearby oil deposits, oil seeps have led to the discovery of most of the world's major oil fields. Oil seeping into Oil Creek led Samuel Drake to drill America's first oil well at Titusville, Pennsylvania.

Yet, despite their importance to petroleum geology, surprisingly little is known about oil seeps. Studies suggest that the younger sedimentary rocks are more likely to be the source of seeps. Also, formations which have been uplifted or disturbed by the more recent of the earth's formative upheavals, appear to be involved. Some seeps occur when deposits of oil have been broken open by movements within the earth. Others occur where erosion has exposed beds of oil-bearing rock.

Although geologists know what causes them, they don't know how many there may be in the world, nor how much petroleum they may leak into the environment. Nor is much known about what effect, if any, submarine oil seeps might have on marine life. Little is known about what happens to oil that escapes from the earth through natural channels, where it goes, or what changes may be wrought in the oil due to exposure to the elements.

Exxon Company, U.S.A. is helping to narrow this information gap.

Exxon helped to underwrite the cost of a detailed study of the Coal Oil Point seeps. And currently, Exxon and 10 other companies, together with the National Sea Grant Program of the National Oceanic and Atmospheric Administration, are jointly funding a major seep study in the Gulf of Mexico.

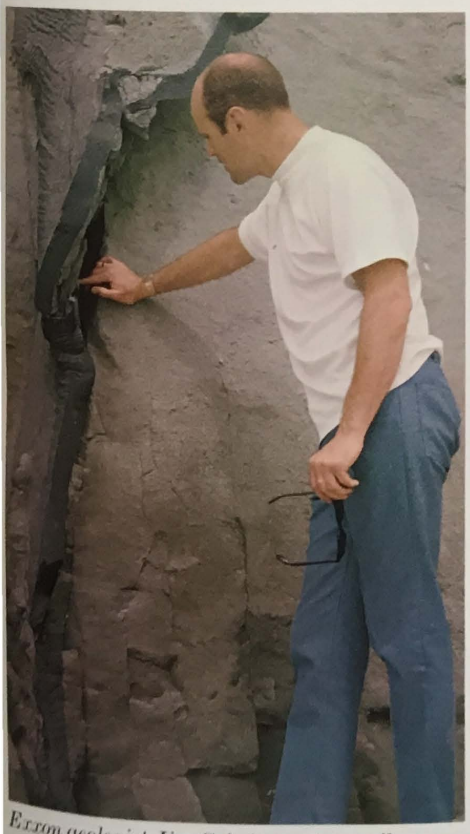
"Everybody complains about tar and oil in the water and on the beaches of the Gulf," says Dr. William Sweet, a geologist at Texas A&M University's Department of Oceanography, which is conducting the study. "Almost automatically, the blame is placed on the offshore drilling rigs and tankers in the Gulf." They may contribute, but Dr. Sweet points out that there is much historical evidence of oil pollution that predates man's drilling. "This led us to investigate, and to try to put everything in perspective," he says.

Involving a staff of eight geologists, geophysicists, biologists, and chemists, the study is now in its second year. Dr. Sweet, as an A&M research associate, is coordinating the project.

One conclusion: natural tar seeps are a source of pollution in parts of the Gulf.

"Many complaints of tar on Texas beaches originate at Padre Island," Dr. Sweet says. "But we've learned in our preliminary work that 90 to 95 percent of tanker shipping is concentrated too far north of this area to be a major source of pollution." Dr. Sweet observes also that lumps of tar found floating in the northwest portion of the Gulf were not refined products, but of natural origin.

"We've traced reports of Padre Island beach tar as far back as the early 1500's, long before drilling," he says. He describes a colorful old hermit who lived in the area during the 19th century. "He made his living by rowing from the mainland to Padre



Exxon geologist Jim Cole inspects an oil seep on the beach about a mile from Santa Barbara.

Oil has been seeping into the world's oceans for thousands, perhaps millions, of years.

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In addition to locating seeps in the Gulf, Dr. Sweet's group is trying to answer ques-ions about them. "We'd like to know if ney are 'seasonal,' or if they leak contin-ously throughout the year," he says. Other questions involve the chemical omposition of seep oil and its effect on the narine environment.

Santa Barbara's oil seeps, which also redate drilling, were once valued as the ource of a useful commodity. Seep tar was ollected from beaches in the 1890's, nelted, and shipped as far as San Fran-isco and New Orleans for use as street aving. Earlier, California's Chumash In-lians used it to caulk canoes, glue arrow-eads to shafts, and mend broken pots.

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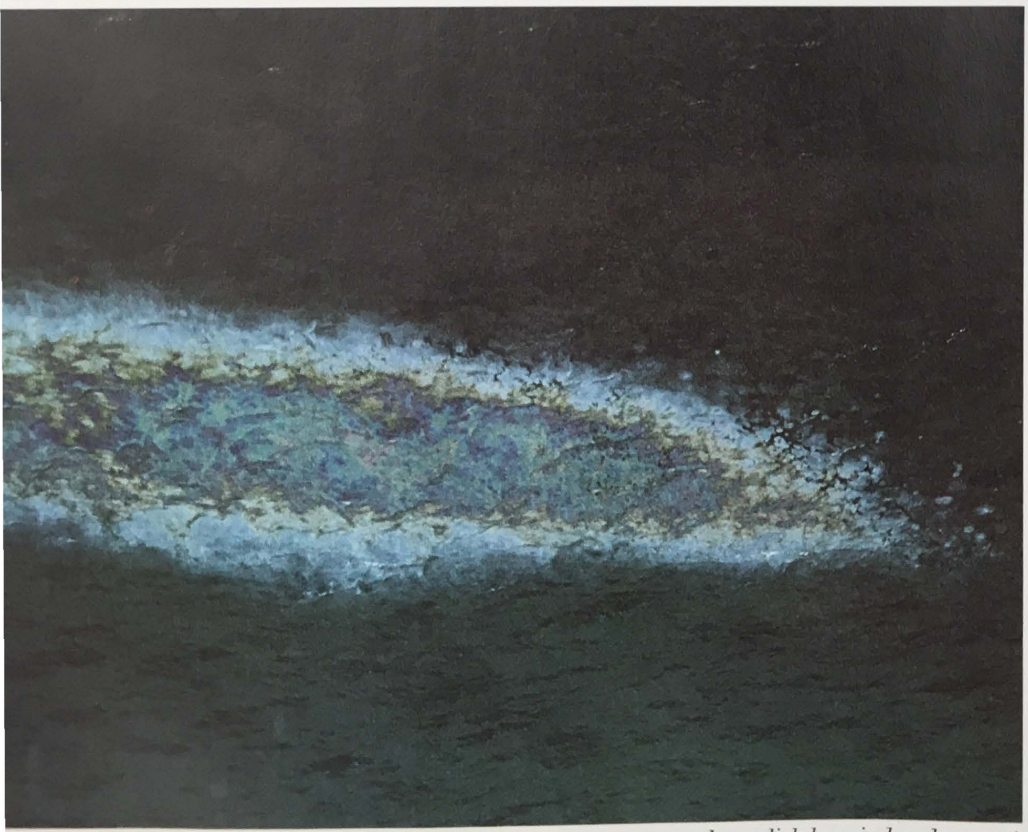
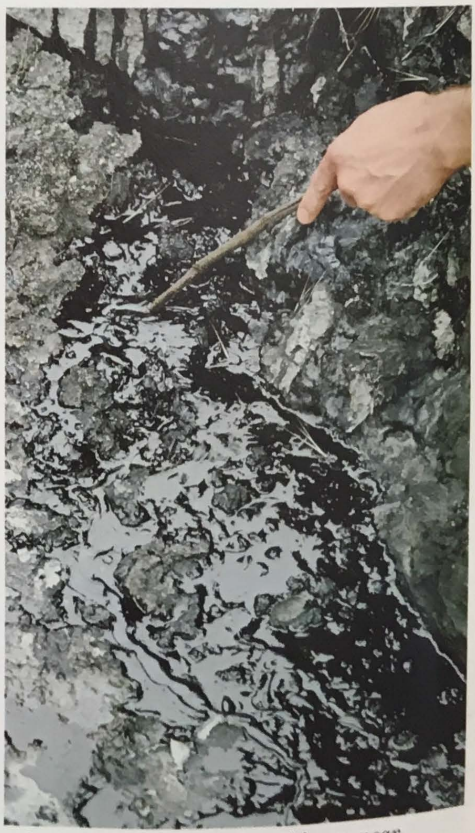
In an effort to understand how much oil might be leaking naturally into California waters, Alan A. Allen, a professional oceanographer and consultant, did some calculations on the Coal Oil Point seeps. Following the 1969 Santa Barbara blow-out, he used aerial, surface, and under-water investigative techniques to calculate rate of flow. The Coal Oil Point seeps, he found, leak from 50 to 70 barrels of oil a day (between 2,000 to 3,000 gallons) into the Santa Barbara Channel, and have probably been doing so for centuries. Using the lower figure, Dr. Allen estimates that nature is putting around 18,000 bar-rels of oil a year into the channel.

To the eye, however, the seeps are not too apparent. "Marine seep oil isn't some-thing that looks the same day after day," Dr. Weaver points out. "Some days, you can see a tremendous slick out there. On other days, it isn't as obvious. It's subject to wind, tide, and a lot of factors."

James M. Cole, a geologist working for Exxon in Los Angeles during 1969, agrees. Almost every day during the summer months after the Santa Barbara blowout, Cole examined the Coal Oil Point seeps from the air. "They were always there in various shapes and sizes," he recalls.

According to Dr. Weaver, the Santa Bar-bara seeps are tens of thousands of years old. A respected environmental geologist and stratigrapher, Dr. Weaver has studied Santa Barbara for 15 years. He says that the oil seeping from Coal Oil Point comes from a brittle and much-fractured rock formation called the Monterey shale. It lies near the surface of the ocean floor at Coal Oil Point and readily leaks oil into the sea there and from the cliffs at the water's edge where it is exposed. Further out in the channel, Dr. Weaver states, the formation





Oil seeping to the surface at Coal Oil Point is borne away as a long slick by wind and current. Inland oil seeps (right), such as this one near Ojai, are fairly common in California.

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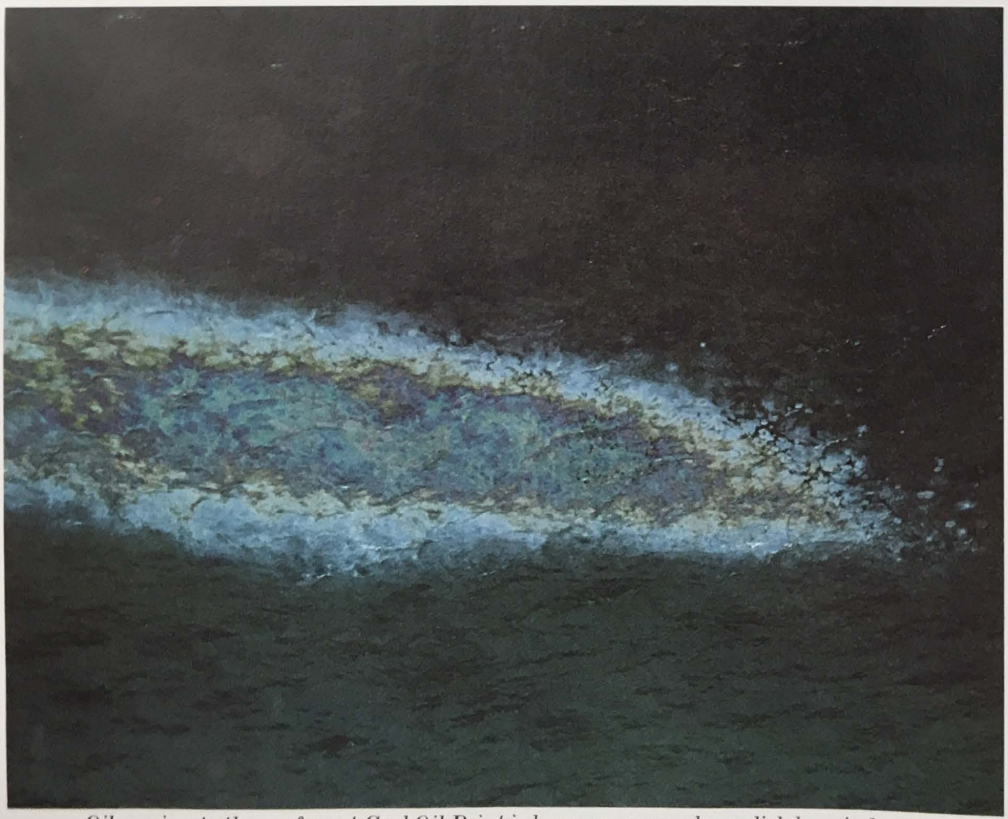
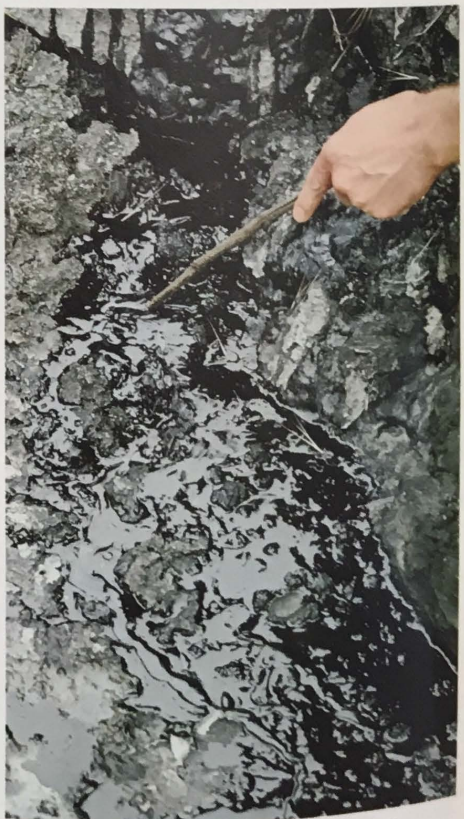




Oil seeping to the surface at Coal Oil Point is borne away as a long slick by wind and current. Inland oil seeps (right), such as this one near Ojai, are fairly common in California.

is deeply buried under layers of younger rock formations. Here, practically no oil escapes to the surface.

The Coal Oil Point seeps have their counterparts elsewhere along the California coast. One major seep off of Redondo Beach regularly leaks oil onto the beaches of one of the state's most populous areas.

Californians to whom the seeps are a nuisance have asked if they can be stopped, or if the oil could be cleaned up before it gets on beaches. Geologists say this is possible. Dr. Allen suggests the possibility of controlling seeps by injecting a gelling agent into the formation in order to seal channels through which oil escapes. Or, as both Dr. Allen and Dr. Weaver suggest, wells could be drilled to extract the oil from the reservoirs that supply the seeps. Dr. Weaver points out that a seep at More Mesa dried up when gas was withdrawn from the nearby La Goleta gasfield. "This eliminated the driving force, or pressure, which was causing the seep to flow," Dr. Weaver believes.

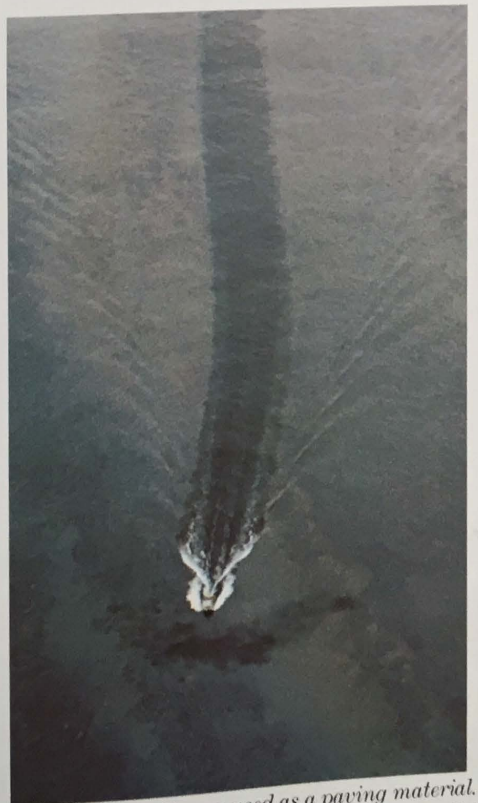
As to cleaning up oil placed in the sea by natural oil seeps, Californians would find it shockingly expensive. Exxon engineers using the Coal Oil Point seeps as a handy place to test clean-up devices, found that oil could be collected with booms and skimmers at a cost of $4,000 a barrel. Thus, to collect 50 to 70 barrels of oil from the water's surface—the average daily production of the Coal Oil Point seeps—would cost from $200,000 to $300,000.

However, such an effort and expense may not be necessary. Dr. Sweet points out that while Mother Nature pollutes her oceans, she also cleans them up. "With oil seeping to the surface for centuries, and tar washing up on beaches daily, it would be reasonable to suppose that it would soon cover the beaches completely," he says. "But it doesn't. In time, it disappears of its own accord with no apparent harm to the environment."

One reason for this may be that oil is a natural organic substance, formed out of the remains of plants and animals, and is itself food to some kinds of organisms. A host of microorganisms eat oil, and digesting it, convert it eventually into carbon monoxide, water and other simple substances. A scientist in Trinidad reports that he has found three species of clams which thrive in an oil-polluted area along the island's shores. Although his findings are incomplete, he believes that the clams relish the organisms which attach themselves to oil rather than the oil itself.

Dr. Sweet concludes that oil seeps offer relatively little danger to the environment. He points out that oil is rated as perhaps the least harmful biologically of aquatic pollutants, and that oil seeps have been around for thousands of years. "I don't think they've been responsible for any biological extinctions," he says.

"I don't think we should worry about seeps any more than we do volcanoes," Dr. Sweet believes. "We never tried to stop a volcano, we just learned to live with it. Why shouldn't we do the same with Mother Nature's oil wells?" ■

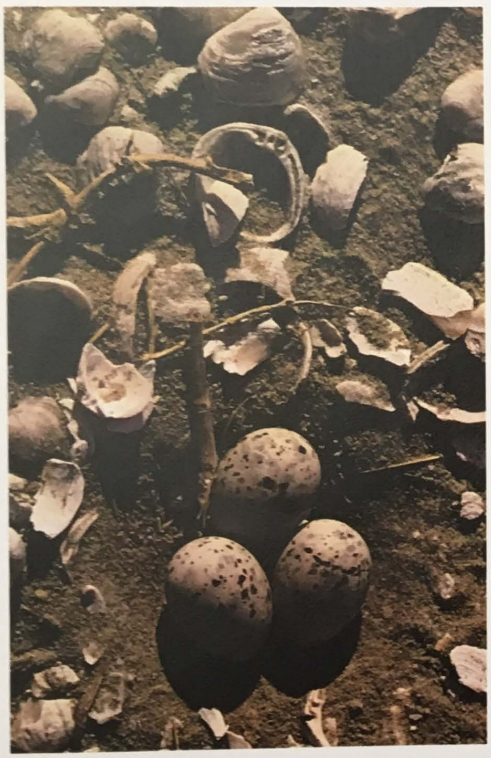


At the turn of the century, tar seeping onto California beaches (left), was used as a paving material. Over 50 barrels of oil seep into the ocean daily at Coal Oil Point, (center), creating an oil slick five or six miles wide. Bathers (right) find a broad California seep a nice, dry spot to spread a picnic.

return of the terns

If you enjoyed seeing the swallows come back to Capistrano, you'll love watching the terns return to Exxon Company, U.S.A.'s Grand Isle Gas Plant. Each April, right on schedule, thousands of the small, gull-like birds flock to this small island in the Gulf of Mexico. After flying 500 miles from the Yucatan Peninsula to Louisiana, the birds settle down within the gas plant confines to build nests and raise families.

Why Exxon's gas plant? Ornithologists say Exxon did the terns a good turn when the company brought in thousands of



Tern eggs, above, blend perfectly with surrounding clam shells. Terns, at right, arrive in April, nest in June, leave in September.

By Joe Tucker, Humble Way, *Third Quarter 1972.*

cubic yards of clam shells as a foundation for the maze of shiny towers which remove petroleum liquids from natural gas produced from nearby offshore platforms.

"The terns find an ideal nesting site among the clam shells," says Dr. George Lowery, Jr., professor of zoology at Louisiana State University and director of LSU's Museum of Natural Science. "They simply scratch out a small depression amid the shells, turn around a few times, and lay one to four speckled, cream-colored eggs. The birds and their eggs are perfectly camouflaged among the shells."

Gas plant employees welcome the migration each spring and do what they can to make the visitors feel at home. Burly oil workers spend hours locating the nests and marking them with stakes so as to warn away visitors. Vegetation goes uncut. Paths and walkways are rerouted to bypass concentrations of nests. Eggs laid in roadways are carefully moved to nests where foster mothers readily take them under their wing. Young chicks wandering onto roads are shooed back to the safety of the plant.

In September, as the days get shorter and the avian barometer indicates good flying weather, the terns prepare for their journey abroad. When the time is right, birds fill the fall sky as they head south to their wintering grounds across the Gulf.

Commenting on the phenomenon, a New Orleans outdoor writer says, "If there is any environmental conflict there, someone forgot to tell the terns about it, not to nest, that is, in the petroleum complex where they are bringing up their young by the thousands." ■

Employees of the Exxon Grand Isle Gas Plant mark nests to guard them from damage.

Tiny chicks mature sufficiently in three months to migrate with their parents to the Yucatan Peninsula.

when the last oilman leaves Avery Island

Though it rises miles from the nearest sea waters, Avery Island merits its name. Seen from the air, the two-mile-wide mass thrusts 150 feet up from a level marsh as much water as solid land, a trembling earth so unstable that the true coastline changes almost daily.

The thin skin of soil over the island covers an immense salt dome, probably deposited uncountable millions of years ago in the drying of primordial seas. Upland fauna and flora found a home there in ages past, partly because of the elevation above the surrounding marsh and partly because of the precious salt licks oozing up from the underlying dome. Man soon followed. Recent archeological digs near the modern salt mine suggest that primitive man lived on Avery Island 12,000 years ago. By 1790, records show, a settler named John Hays had moved in. More than 150 years ago, ancestors of the

By Bern Keating, Exxon USA, *Fourth Quarter, 1973.*

ent Avery-McIlhenny family took the island operations. Beginning late e last century, they began polishing r little island-dome to make it a world-ed beauty spot. They planted exotic eas and bamboo; they nurtured native ts and preserved wilderness patches the moss-hung cypress brakes where ingas (the natives call them water tur-s) today fatten on teeming schools of fish. Tourists flocked in to see the "jun-gardens" in increasing hordes till it be-ne unthinkable to pass near New Iberia hout visiting the island.

About the turn of the century, when the owy egret's numbers neared the critical int for survival, E. A. McIlhenny pro-cted several bird families from plume nters. Descendants of that seed flock now number in the hundreds of thou-sands. The egret rookery is only one of several long-established environmental projects that reflect an intense concern for preserving or enhancing the beauty and the wildlife of the island and the sur-rounding marsh. And the owners have now apparently fostered an even more far-reaching improvement affecting the future of the marsh.

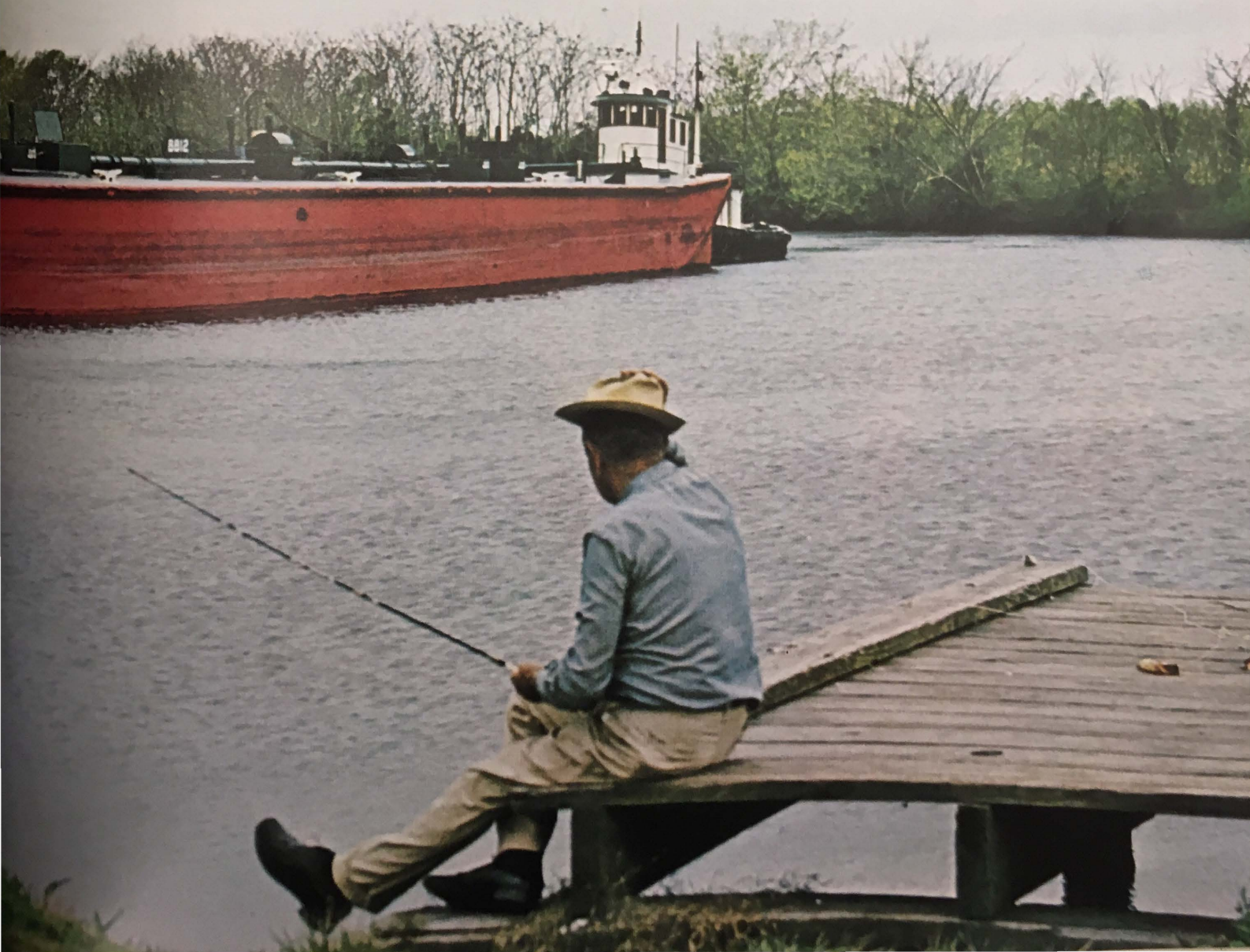
It came about this way:

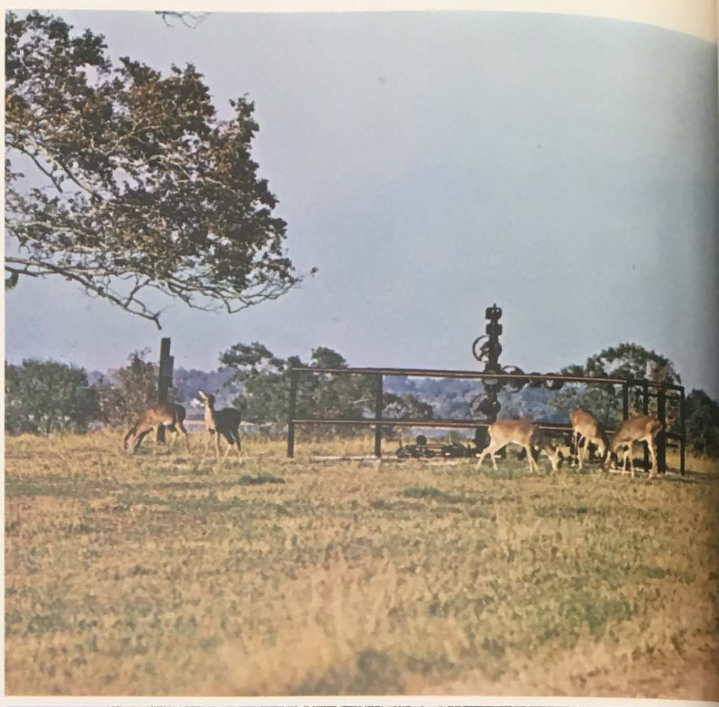
Salt domes attract oil explorers. In the chancy business of hunting for oil, wild-catters discovered that the percentage of success near salt domes is just enough larger to make the gamble less risky.

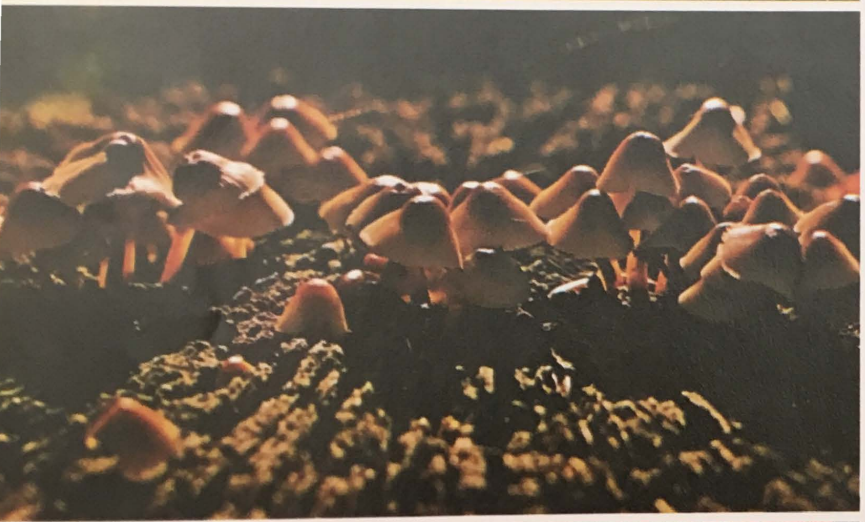
Nevertheless, primitive efforts to find oil at Avery Island's salt dome failed in the early 1920's. In 1939 and again in 1941, two major oil companies drilled wells to depths of more than 12,000 feet, but found nothing of commercial value. Then, in August, 1942, with that capriciousness of luck that maddens oil explorers, Exxon Company, U.S.A. brought in a fine dis-covery well. Since then, Exxon USA has drilled 121 wells around the southwest rim of the salt dome, 24 of them dry holes and 97 producers. Out of the producing reser-voir have come 75 million barrels of oil, 80 billion cubic feet of gas, and 1.6 million barrels of condensate.

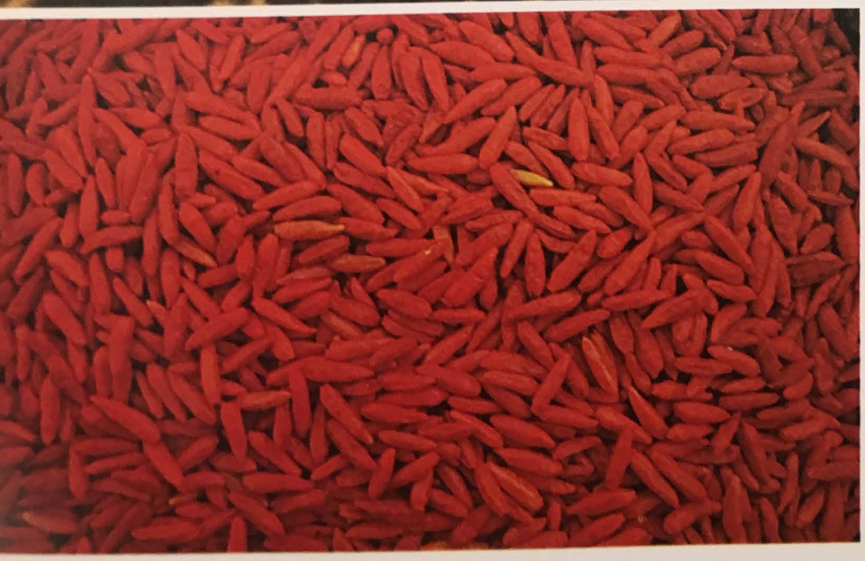
Because of that booming production, the school of conservationists who suffer from petroleophobia despaired of the ul-timate health of the surrounding marsh. They would not deny that on the island it-self beautiful gardens, lush stands of un-disturbed semitropical vegetation and cy-press brakes sheltered a teeming bird and animal population while screening off vir-tually all signs of the intense oil activity going on behind the scenes.

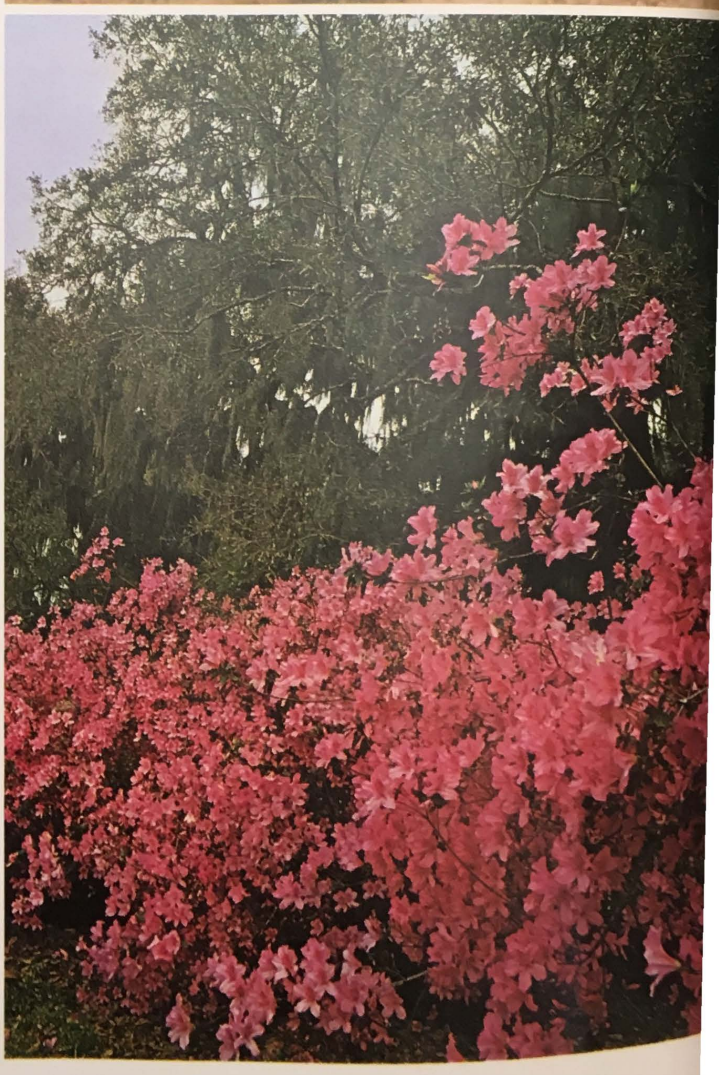
But conservationists worried about the effects of canals which Exxon USA had to











dig in order to reach some of the drilling sites. Bayou Petit Anse empties into the Gulf of Mexico, and tidal surges occasionally bring salt water up this natural channel. Critics feared that offshoots from the bayou might introduce salt water into the marsh and bring about change in the ecosystem there. Where this occurs, stands of marsh grasses may be replaced by more salt-tolerant species.

At the Louisiana Wild Life and Fisheries Commission, I learned from game management experts that canals are virtually impossible to eliminate. Once dug, they are there for good because the spoil thrown up on the banks—the only material available for refilling the canals—compacts and oxidizes to half its former bulk.

"Just wait until the field plays out and the oil money stops," a conservationist friend warned me. "The marsh will be a maze of abandoned canals pouring salt-water tides into the lowlands forever."

Well, the testing time has come, for the oil is indeed playing out.

Canals dredged for oil drilling have become homes for fish and waterfowl. Mushrooms flourish amid jungle-like surroundings on Avery Island; elsewhere on the island farms produce condiments for famed Tabasco sauce. Avery Island's jungle gardens feature rare species of azaleas and camellias. Upland game have returned to Avery Island; here, deer browse beside a producing oilwell.

"The field is approaching depletion," says Tom Hurst, Exxon USA's district manager. "We expect daily production to decline sharply in the near future."

Visiting the dying oilfield at Avery Island to find out how the marsh would fare when the canals are abandoned, I talked to Walter McIlhenny, president, and Edward Simmons, treasurer, of Avery Island, Inc.

"We're conservationists, but we're businessmen, too," Simmons states. "We're land managers with the job of getting the most return out of our land holdings while working the least change in the environment. We happen to own the marshland affected by the canals, and we have no intention of letting several thousand acres between here and the coast become a salty desert."

Evaluation of the marsh by a team of soil management experts has established that the land is useless for farming. According to the experts, its most appropriate use is for wildlife management—especially for ducks and geese and furbearers—with only limited cattle-grazing near the dome itself.

Another study by a team of archeologists from Louisiana State University reports that, like every other area on this changing planet, the marsh is dynamic. Examining the sequence of Indian occupation at Avery Island over the past 12 millennia, archeologists learned that the history of man here has been one of constant struggle to adapt to an ever-changing environment.

The first men on Avery Island hunted mammoth, mastodon, two kinds of wild horses, the dire wolf, giant bison, ground sloth, giant tortoise, and the sabertooth tiger. The land was a prairie and woodland mix. The Gulf of Mexico was a full 50 miles away. About 1,650 B.C., after the great glaciers of the Ice Age melted, the sea rose to its present stand about two miles away, changing the land from a woodland to a marsh and driving away the herds of prairie creatures and their predators.

"So our problems of adjusting to new conditions are nothing new," McIlhenny observes, "and they are not nearly so severe as the changes primitive Indians were forced to face unaided by the resources of modern technology."

Spreading out an aerial survey map of the region, Simmons points to the turbid waters of Bayou Petit Anse which rims the knob of Avery Island. Like spokes of a wheel, finger canals lead from the bayou to wellheads along the island's southwestern flank. Muddy bayou water fills most of the canals, but in three canals leading to wells no longer producing, the water is clear.

"We dammed the abandoned canals from the main stream," Simmons explains, "and almost overnight, the mud settled and the water began to freshen and clear." Avery Island plans to stock the new finger lakes with bass, perch, and other native freshwater fish to provide controlled fishing in an area where there has never been enough pond area to support the sport before.

As more canals are closed and become fish ponds, salty tidal waters carried inland by Bayou Petit Anse will no longer have an outlet into the marsh. When marsh waters sweeten, ducks, geese, muskrats, otters, nutrias, and raccoons will return. Surveys indicate that much marshland will be restored—enough to support many thousands of migratory waterfowl. And commercially valuable furbearers will once again make their home in the area.

Canal spoil banks will contribute to habitat improvement, as well. During the 30 years since the spoil banks were raised above the surrounding lowlands, upland vegetation has moved in. Chinaberry trees, willows, and upland grasses have taken root to provide browse and cover for a complex upland ecosystem that never existed in the marsh before the dredge provided an artificial upland. Live oaks provide the mast necessary in deer diet. A flock of about 200 imported red jungle fowl has become firmly established through four generations. Migrating songbirds rest and feed in the upland trees. During hurricane tides, furbearers and upland game such as deer and raccoons keep their feet dry on the spoil banks while their cousins drown by the thousands elsewhere in the marsh.

On a boat tour of the bayou, canals, and marsh with Raymond Bonin, I get a close look at dense stands of exotic vegetation thriving on the spoil banks. According to foresters, indigo, giant bamboo, and chinaberries "escaped from plantations" and established themselves in the wild.

Tying up to a willow already flourishing on a new earthen dam shutting off an abandoned canal, Bonin beckons me to the top of the bank.

"You see the muddy waters in the bayou outside the dam?" he asks. "Can't catch nothing but catfish in the bayou, and it tastes like a handful of mud pie. But the clean water inside the pond now is going to be full of bass and perch, and good to eat, too, on a heap of rice with a shake of Tabasco over it."

Bonin identifies in Cajun French the plants growing on the spoil banks: *Monglier* for myrtle, *chene vert* for live oak, *camphier* for camphor, and *roseau* for tall marsh cane. He remembers when the spoil banks stood naked and ugly beside newly dredged canals. "And look how pretty now," he says. "Sometimes I see an otter playing on the bank here where he never used to come when I was a boy. Sometimes a deer. Birds come by the hundreds and I didn't even know how you call them in French or English, they are so new here."

So, the spoil banks and finger canals, once dreaded by conservationists, have worked a change in the dynamic marsh habitat which appears to be as beneficial to wildlife as any change during the 12,000 years of its environmental history. When the last oilman leaves Avery Island, the marsh will return to its original fresh and brackish ecosystem—but with the addition of a chain of fish ponds and a thriving upland habitat crisscrossing the marsh in a network of abandonded spoil banks grown up to dense stands of game-rich grasses and hardwoods. Change may be inevitable, but if you plan properly, it can be a change for the better. ■

APC has a story to tell
Of its plant and the neighbors as well.
Relations once grated
'Til pollution abated.
Now everyone gets along swell.

EDITOR'S NOTE: *The limerick was written by the editor. The other limericks in this article were winners of the APC environmental promotion contest.*

When the Altona Petrochemical Company (APC) opened in November 1961, its closest neighbor was more than 400 yards away. Most of the residential section of Altona, a community located 10 miles west of Melbourne, Australia, was a half mile away. The towers, furnaces, compressors and pipelines of APC were surrounded by open fields, a swamp, Kororoit Creek Road and Maidstone Street.

Within 10 years, the picture had altered considerably. APC's plant had developed into the fulcrum of a group of companies called Altona Petrochemical Complex with more than a US $260 million (Australian $200 million) investment.

Feedstocks from the local oil refinery and Bass Strait natural gas are piped to APC's plant. There, they are cracked into ethylene, butadiene, propylene and carbon black feedstock and distributed to 10 other companies in the Altona Petrochemical Complex including Monsanto Australia Ltd., Dow Chemical, Australian Synthetic Rubber, Union Carbide (Aust.), Hoechst (Aust.), B. F. Goodrich, BASF (Aust.) Ltd., Australian Carbon Black and Marbon Chemicals (Aust.) Ltd. Their products go downstream for use in consumer goods ranging from home insulation, and carpet backing to pharmaceuticals and textiles.

While the chemical complex grew, the community expanded, too. By 1971 the population in the area had doubled to 30,000 people. To accommodate the population, local zoning laws changed so that houses began to line streets that did not even exist when the APC plant was built. Today, houses are within two hundred yards of the plant and school children at new schools play soccer with a view of APC's steam cracking towers.

"When the APC plant was new, our priorities were making a quality product, making a profit and providing challenging and interesting work for employees," explained Joe Waugh, APC's environmental coordinator. "A combination of growth and increased awareness of the need for environmental conservation and pollution control have had a tremendous effect on how we operate and think at APC. Today we are very conscious of our impact on the community," Waugh said.

When APC was built it was equipped with a number of pollution control devices. But an incident on November 9, 1971, brought home the fact that existing equipment was no longer enough to maintain a positive community image.

On that day two spills occurred: a caustic soda spill coincided with one of sulphuric acid. The ensuing effluent water released a sulphide odor at the weir of the APC separator which was detected in the local community.

"We got a lot of complaints that day," said Waugh. "That's when we realized it was time for us to concentrate even harder on showing our neighbors we cared about them and the environment."

What had been sufficient for industry and the public in the 1960's was no longer good enough for anyone, particularly the APC plant. "We decided that year that significant improvements had to be made in environmental protection," Waugh said. "We launched a major anti-pollution campaign and began to think more about our role as part of the Altona community."

Today, after an expenditure of more than 100,000 man-hours and US $2.0 million (Aust. $1.53 million), the APC plant and the people of Altona share an open relationship of mutual respect. But it was not easy to achieve.

"In addition to the need to respond to environmental awareness, we also faced a problem of unawareness," said Jay Dalgetty, APC's general manager. "In 1971 a community study revealed that less than 50 percent of the people in south Altona knew where the APC plant was located in the chemical complex or what the company actually made. Many people in the area would relate any noise, odor or smoke from the complex with us because of the close association with Altona Petrochemical Company. We even share the same initials," Dalgetty pointed out. "We had to educate the public and be willing to accept responsibility for problems that might not be ours."

In the last three years, APC has undertaken a number of projects to help adults and children in the community understand what happens at a petrochemical plant. Two attractive brochures have been produced to do the job. One brochure explains the steamcracking processes, what they produce, where the products go and what familiar items are made from chemi-

Neil Stewart (left) and Joe Waugh were instrumental in making APC's environmental/community relations program work.

cal raw materials. The other brochure testifies to APC's commitment to keeping Altona clean. It also details the monitoring equipment installed at APC, such as TV screen controls and anti-smoke flares and the plant's regular surveillance procedures. This second brochure also introduces Joe Waugh, the plant's environmental coordinator, and assures the community that Neil Stewart, then chairman of the plant's environmental control committee, and the committee members are at work to prevent damage to nature. (Stewart has since been named project manager of the facilities planning group.)

Another aspect of the education program occurs annually when more than 250 students from six local high schools tour the plant. These visits make an unfamiliar industrial process something understandable and interesting. One other APC program aimed at communicating with the local neighborhood is the plant's annual fire protection session held in October.

"We have our safety coordinator, Ron Courtot, lecture on fire prevention and show the students all our various pieces of fire fighting equipment," explained Stan Noble, public affairs coordinator who arranges the program. "Fire prevention is of great concern in this community because

The environment protection authority
Gives air and water priority.
So, to keep them both pure
Don't drain to the sewer
Compounds of great notoriety.

we can have heavy bush fires between the months October to January. Our fire prevention programs are highly valued. We show our defense against fires and let the community know that we care. Some adults, press people and local council representatives usually come to the demonstration, too," Noble said.

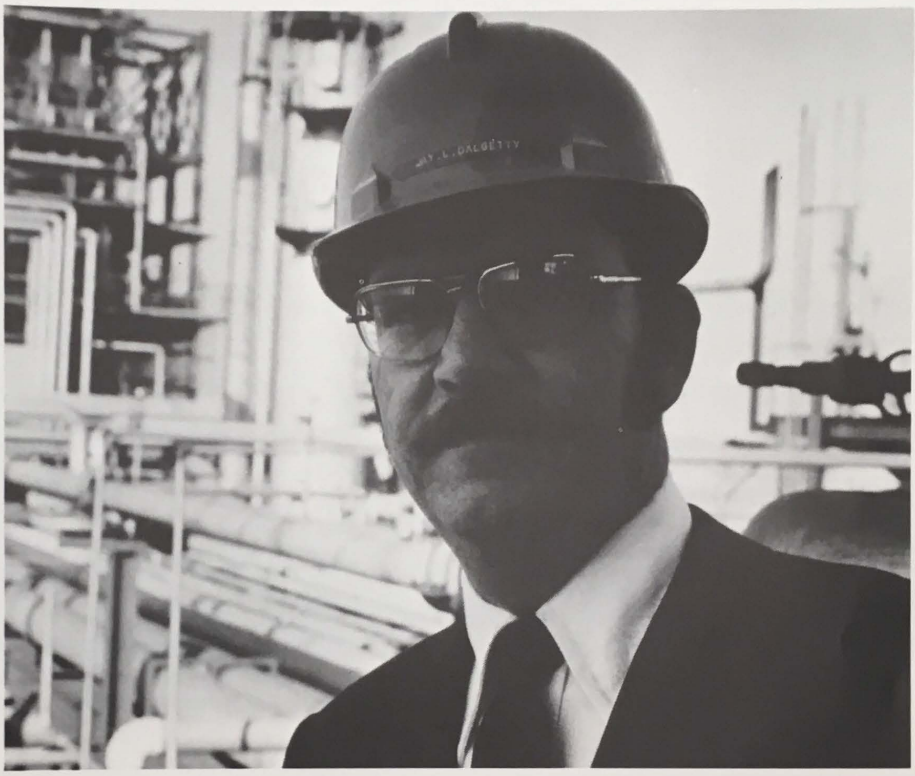
Joe Waugh reminisced about the early days of APC's community relations. "Now that I look back on our first attempts to smooth over the community's reaction to that incident in '71, I consider our work a shoestring effort. It took us two or three months to coordinate a good program. Initially, everyone tried hard to keep odors, noise and smoke from leaving the plant, but sometimes we weren't successful."

Waugh was appointed to his post of environmental coordinator in February 1970. Prior to this, a group of five men were chosen to be the plant's environmental control committee. Neil Stewart headed the group's organized attack to meet the plant's own environmental standards and to initiate a continuing program to monitor plant environmental performance, promote the education and awareness of employees and improve communications with external authorities.

Regularly, an operator from the APC shift on duty visits seven community checkpoints. He checks the air quality, meters the noise level in number of decibels registering at these locations and looks for smoke or fumes. If a complaint from the community is received either directly or via the Altona City Council's 24-hour answering service, the superintendent immediately checks the details of the complaint and takes remedial action if required. Most of these complaints are found not to have originated at APC.

In addition to all the equipment checks, shift pollution reports, and inspections of Kororoit Creek, APC has installed new plant facilities to overcome potential pollution problems. Included are sand filters to extract copper deposits, special caustic neutralization facilities, enclosure of the atmospheric vents on the sour water stripper and naphtha rerun tower and an addi-

Joe Dalgetty, general manager



tional elevated, smokeless flare. The operators carry out checks on the pollution abatement equipment just as they do on any of the plant's process units.

"We think our pollution control investment is as valuable to us as product quality these days," commented Waugh. "And for that reason all the treatment and control equipment must meet specifications."

On the outside of the plant's premises the environmental control committee members work closely with the local authorities on the Altona City Council. "We keep local health officials appraised of what's happening at APC. We've come to the conclusion that the safest and best way for us to deal with the Council and the community is in a fresh and open manner," said Duane Pugh, plant manager, who was recently appointed the new environmental control committee chairman. "At Altona Environmental Council meetings, local industry representatives sit down with City Council members and we all discuss problems, solutions and current or impending situations in the community. It is all a part of being credible," Pugh said.

The environmental control committee probably set APC's toughest goal last January. After achieving a substantial decrease in the number of complaints from the community over the previous months, the committee suggested that the plant set a goal of 100 days free of complaints. A large scoreboard was set up outside the main control room building. On November 9, 1974 (exactly three years after the plant's turning point in environmental outlook), APC reached its 100-day objective after pushing toward it for 10 months.

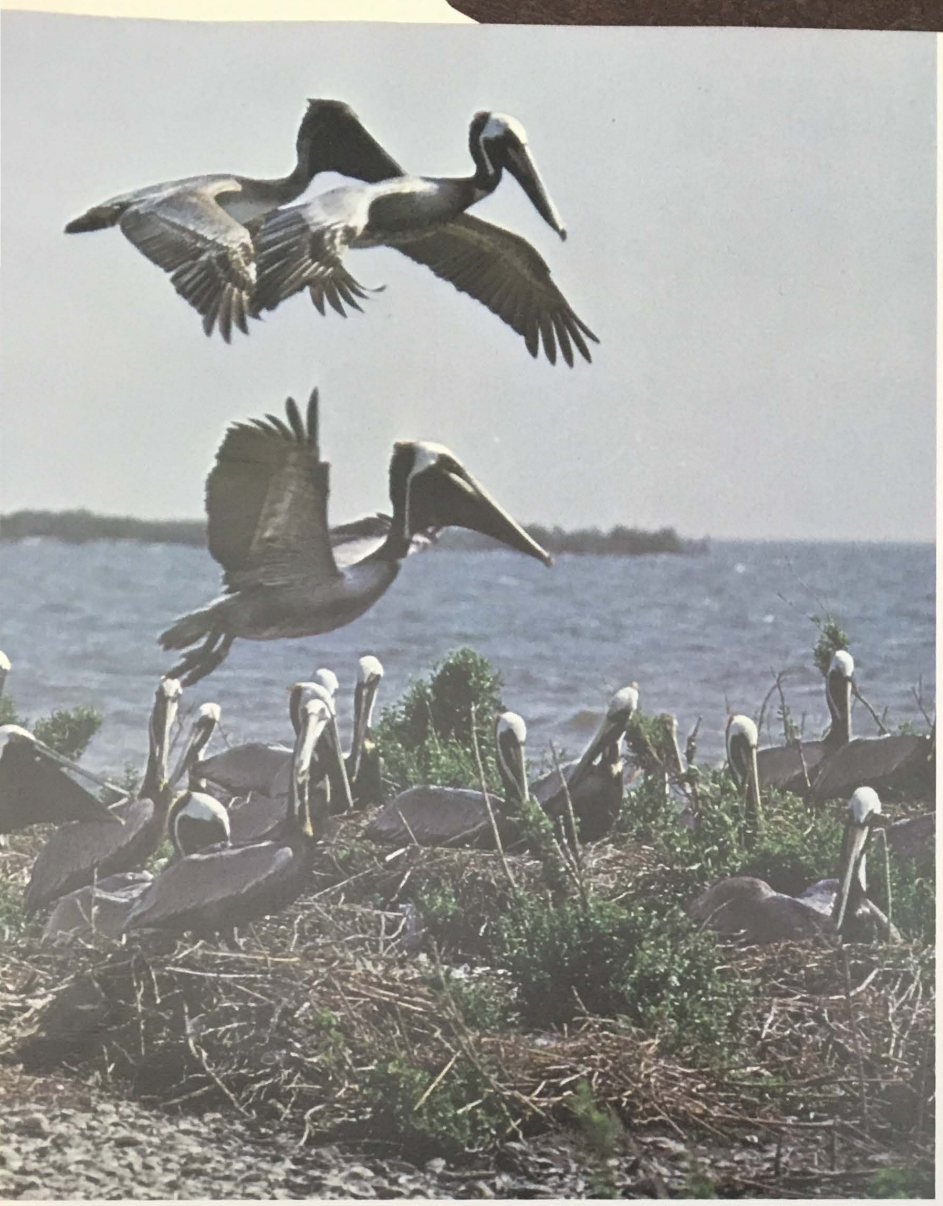
"We were very stringent with ourselves while trying to attain our goal," said Waugh. "We decided that if a complaint were received and if the wind were blowing from our direction—even if the odor were not from something we make—we would accept the responsibility. It may sound as if it were a little unfair to our employees, but it was the only way we could maintain credibility within the Altona community."

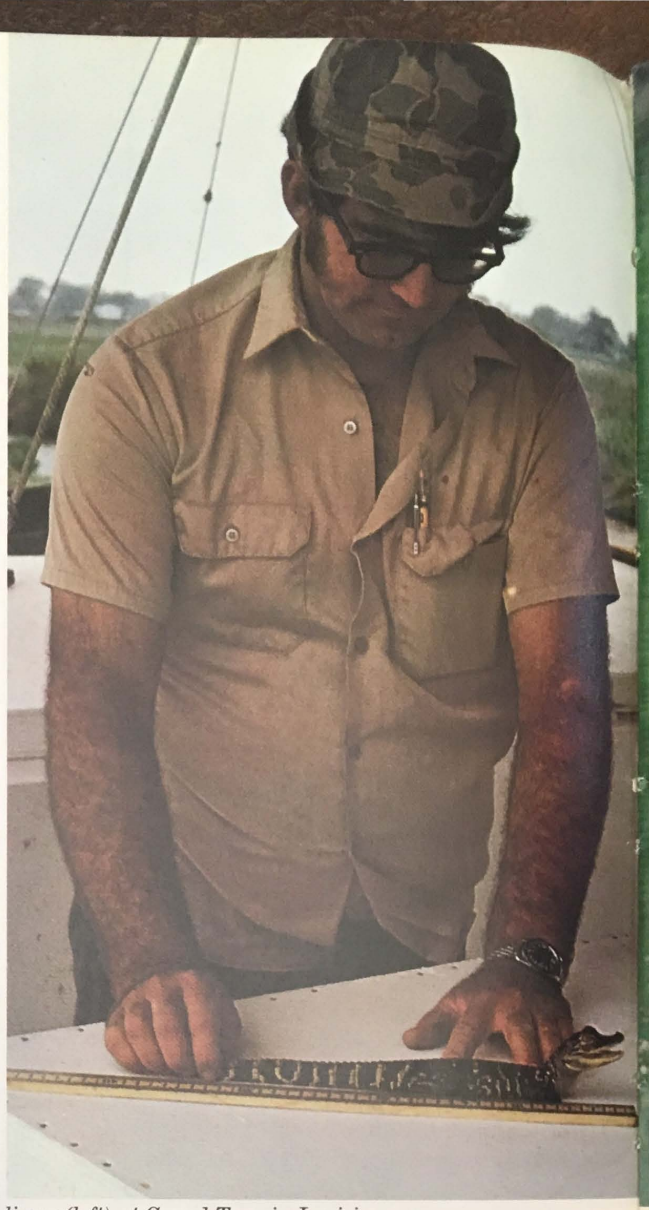
Now that the objective has been achieved and the 100-day mark is met, the difficulty of the goal has made everyone at APC doubly proud of the accomplishment. "Everyone felt a lot of personal satisfaction in this achievement," said Jay Dalgetty. "The challenge will be to continue this level of employee awareness and strive for further improvement."

A limerick on anti-pollution
Is certainly not the solution.
But it will ring a bell
When detecting a smell,
Thus making a real contribution.

Time and money have been invested at the APC plant to combat pollution but hours and dollars also are being spent outside the plant. "We have invested in community projects and programs that are important to the town. We did it to help and to show that we consider ourselves a real part of this community and that we want to see it do well," said Stan Noble. APC has awarded scholarships, given special equipment to schools and assisted in fund-raising programs for the local community. "It's important to get involved with the people who live in your community, not just in a defensive action plan. Now that we have become involved, we've discovered that involvement is the really necessary part of our program to make friends with Altona," said Noble.

Joe Waugh claims his job as environmental coordinator won't be a success until he has nothing to do. It looks like APC plant employees are trying hard to make him successfully unemployed. ■





Oil royalties helped to finance establishment of a resident flock of brown pelicans (left), at Grand Terre in Louisiana. Biologists report an alligator population explosion at Marsh Island Refuge, where Exxon USA wells flow.

the greening of the refuge

By Bern Keating, Exxon USA, *First Quarter 1974.*

Between the Louisiana wildlife refuges of Salvador and Pointe au Chien, the coastal marsh southwest of New Orleans changes from freshwater to brackish. In place of puddleducks, white pelicans swirl up from salty ponds in flocks so dense as to blot out half the horizon.

My pilot, Al Ensminger, skillfully lays the light plane's floats almost on the sodden marsh to skim over two of the state's newest coastal refuges. As director of refuges for the Louisiana Wild Life and Fisheries Commission, Ensminger is checking on the health of the grasses of the marsh and the wildlife the grasses support. He shouts the history of the two refuges above the engine's blast.

"We bought these 55,000 acres in October, 1968, from Exxon USA," he explains. "Paid only $21 an acre. Practically a giveway. These two tracts have become the most heavily used of any refuge in the system, by wildlife and by sportsmen."

Dimly visible through a cloud of flying water birds, a tank farm squats in the marsh. "What about oil operations," I ask. "Are they still producing oil here?"

"Oh, Exxon kept the mineral rights," Ensminger says. "There are about 50 oil wells and two gas wells producing now, and more coming."

I ask about migratory birds. "Don't oil operations endanger them?"

"No," Ensminger replies. "Oil operations cause us very little trouble." In fact, far from damaging wildlife, multiple use of refuges under the skilled supervision of game management experts protects resident wildlife, Ensminger reports.

"Take the furbearers," he says, mentioning otter, nutria, muskrat, mink, and raccoon. "The old-fashioned notion was to leave them strictly alone in a virgin wilderness. If we did that here, they'd destroy the marsh and themselves."

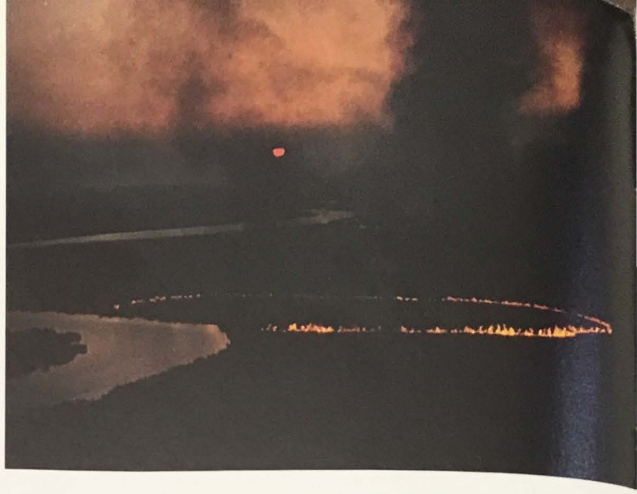
Upper Mississippi River Wildlife and Fish Refuge shelters migratory birds, such as these Canada geese. Royalties from 600 Delta Wildlife Refuge wells, below, may help to feed wildlife in Tennessee or develop nesting ponds in North Dakota.

Ensminger guides the plane over a vast mud flat lying outside the two refuges. It is gnawed over, and nearly naked of grasses. Muskrat lodges, one to every 500 square feet, dot the bare ground.

"This section was not trapped, and the population exploded," Ensminger says. "The rats have become overcrowded. They've eaten everything in sight, and they'll die by the hundreds before long."

Ensminger prescribes a sizable controlled harvest of furbearers by licensed trappers as the best way to keep a refuge healthy. Louisiana tops all states in value of its harvest, almost all of it made in or near refuges, and much of it within sight of oil operations. Fur alone accounted for $10 million in income to Louisiana trappers during the 1972 season.

At the wildlife commission camp on Marsh Island Refuge we swap alligator stories. Ensminger and the refuge supervisor, H. H. Lourd, of New Iberia, agree that Marsh Island and the Rockefeller



Controlled harvest of timber (left) is one of multiple use activities permitted. In the winter, refuge managers burn off dead vegetation (top right) which would smother next summer's growth. New grass rises on the Rockefeller Refuge in Louisiana (lower right) after dead vegetation has been burned away.

Refuge carry the heaviest concentrations of wild alligators of any area in North America, including the Everglades. Refuge biologists estimate one alligator to every two acres, or more than 22,000 on Marsh Island Refuge alone.

"If you ride at night," one of the Cajun workmen says, "you subject to have the 'gators jump in the boat with you."

In 1972 Louisiana gave Alabama, Arkansas, and Mississippi 400 alligators to stock their depleted marshes and bayous.

"We could give away 3,000 more without missing them," Ensminger says. "The whole lot could come from Marsh Island without thinning the stock."

Oil royalties paid for the comeback of the alligator from near extinction, according to Ensminger.

"The nine Exxon wells on Marsh Island bring about $600,000 in royalties yearly," he explains. "After we pay current bills, we put half into a trust fund for research and maintenance. The other half goes into a general wildlife funds. A big slice of the oil royalties bought 120,000 acres of upland forest to expand the refuge system."

Since the late 1950's, according to Ensminger, oil royalties collected for production on the Rockefeller Refuge just west of Marsh Island have exceeded $41 million, with $11 million going to protect and encourage the resident and migratory wildlife and the rest going to the state's education and health budget.

Ensminger's views on oil and gas production on the refuges over which he had jurisdiction coincide with those of Dr. Clarence Cottam, director of the private Welder Wildlife Refuge in South Texas, who points out that wells on his place keep the budget green. A naturalist at Aransas National Wildlife Refuge, a winter home of the whooping crane, says that trails cut through the brush to reach wellheads become game trails, encouraging wildlife to scatter rather than to bunch up in disease-vulnerable concentrations.

In Washington, D. C., Jim Lankford heads the Branch of Resource Management for the Bureau of Sports Fisheries & Wildlife. The bureau administers the 300-plus units of the National Wildlife Refuge System. Lankford adds to the evidence in favor of multiple use.

Of the proceeds from the sale of timber, grazing rights, and minerals, particularly oil and gas, the bureau sends funds (in lieu of taxes) to counties where federal refuges have taken lands off the tax rolls. The remainder maintains existing refuges, develops additional habitat, and aids in enforcement of migratory game bird laws.

"Royalties from the 600-plus wells on the Delta Wildlife Refuge at the mouths of the Mississippi River may well be used to plant waterfowl food crops in Tennessee or to develop nesting ponds in North Dakota," Lankford explains. He adds that these welcome sums reduce the bureau's annual funding requirements each year, providing welcome relief to taxpayers.

"But we make every effort to use natural resources within the understanding that refuges were created for betterment of wildlife for the use and enjoyment of the American people," Lankford asserts. "Every use of a natural resource must pass the test of how it can enhance the environment for the benefit of wildlife."

Citing controlled harvest of timber as one of the multiple use activities permitted on refuges, Lankford explains how logging can improve game habitat.

"Deer, turkey, and migratory birds do better on stands of timber thinner than the usual virgin forest," he says. "So we sometimes open up the canopy to encourage underbrush for browse and cover." Lankford adds that on bottomlands, the refuges sometimes harvest varieties of trees that do not produce mast to make room for the oaks and pecans that furnish the mast essential for deer and turkey reproduction.

At the Federal Upper Mississippi River Wildlife and Fish Refuge, the manager, Donald Gray, explains that the 284-mile-long wetland stretching along both banks from Lake Pepin, Minnesota, to Rock Island, Illinois, exists only because of industry's energy needs, which require that oil products be transported up the river by barge. The bird-sheltering swamp and marsh came into existence only after the U.S. Army Corps of Engineers built 13 dams and locks for navigation by towboats and barges through what became the refuge area. Now, use by migrating birds constitutes an important secondary value of the magnificent wetlands. Where 10,000 wood ducks now hatch annually, where the egret has come back from near extinction, the bottomland used to support almost no waterfowl.

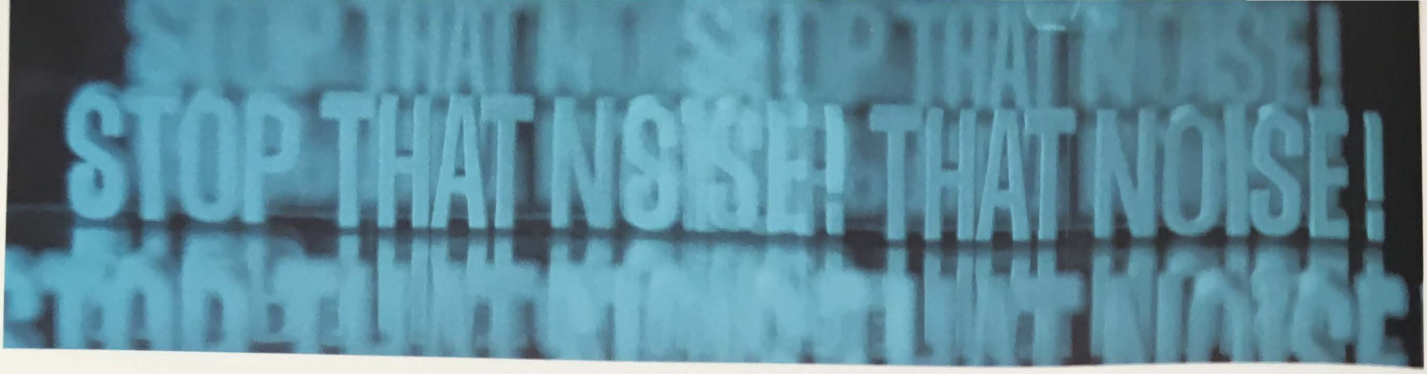
Ensminger wants to hold a deer census on the way back to New Orleans, so we take off at dawn. In the faint morning light, brush fires in the refuge glow brightly. Refuge managers and trappers set fires to burn off accumulated vegetable debris which would otherwise smother next summer's growth. The fires are contained in an area by a network of bayous and canals. The flames crawl along the ground, and just ahead of them several bevies of whitetail deer amble along. The deer pause often to feed, appearing unconcerned. When the flames press them, they escape easily by crossing a bayou.

Refuge managers say game habitat can be improved by selective thinning of timber and the opening of trails. A reddish egret chick (below) calls the Aransas National Wildlife Refuge home.

Flocks of birds rise beneath the aircraft. We note mallards, teal, baldpate, ibis, four kinds of herons, lesser scaup, three kinds of hawks, killdeer, sandpipers, coots, and gulls. As the air warms, alligators crawl onto bayou banks to sun themselves. Nutria dive for underwater roots. The marsh teems with life.

Offshore in Vermilion Bay, a cluster of platforms marks the Lake Sand field. Ensminger studies the installations carefully before speaking.

"What a bad break," he murmurs. "They found gas a mile-and-a-half out in the bay instead of in the refuge. The wildlife could have used the money." ■



Progress has spawned thousands of rambunctious noises that are insidious, harmful, and pervasive. Disturbed by the mounting decibels, citizens, legislators, and companies like Exxon have launched a quiet offensive.

A highway patrolman in Connecticut checks an instrument on his dashboard and then aims a television camera at a passing truck whose broken muffler is howling. A New York City bank advertises for a deaf girl to work in its cacophonous check-tabulating room. A man standing beside a large yellow machine on a Los Angeles construction site suddenly jumps three inches and claps his hands to his head as the compressor roars into life.

All three scenes are part of the same play. It is titled *Noise: An American Story.* While the script lacks the impact of tragedy, the story is no laughing matter. Noise is a threat to body and mind, and over the last fifteen years it has grown 800 percent in U.S. cities. Urban noise now doubles every decade. The opening speaker at the 1969 symposium of the National Council on Noise Abatement summed up the situation. America, he said, is the noisiest country on earth.

Noise is insidious, and that is one of its chief dangers. People who are constantly bathed in noise do not hear it, or they think they do not. But their bodies do, and they suffer the fraying effects of constant sound abrasion. Even moderate noises cause blood vessels to contract. The skin pales. Muscles tense. Adrenalin pours into the bloodstream. All this happens whether a person is awake or sleeping. The reaction cannot be controlled—except, of course, by reducing the noise.

Physicians say that noise contributes to ulcers, heart disease, psychoses, and neuroses. People who work amid loud noises can also have their hearing permanently impaired. In June, 1968, the U.S. Surgeon General noted that as many as sixteen million Americans may be suffering ear damage from on-the-job noise.

Such warnings are being heard—despite all the noise. Citizens' groups have sprung up all over the country—Citizens for a Quieter City, the Society for the Suppression of Unnecessary Noise, the League for Less Noise, the National Council on Noise Abatement, the Committee for a Quiet City, and others.

Private industrial companies, such as Exxon Corporation, are accelerating their war on noise through intensified research into noise control and redoubled efforts to reduce the noise level at their plants.

At least a dozen federal agencies are involved in the noise question. Five studies have been undertaken, and the government is backing an extensive investigation by a special committee of the Federal Council for Science and Technology.

Noise is not a new problem. In ancient Rome, citizens complained about the incessant cracking of drivers' whips, and Julius Caesar was bothered enough by the rattle of chariots to ban them after dark. Yet some people deliberately seek out noise—for instance, the thousands of "rock" enthusiasts who jam into discotheques to dance to thunderous music.

This audio overexposure has its consequences. One man, driving his teen-age daughter home from a discotheque, was disconcerted to find that she hadn't heard a word he said all the way home.

Recently, a discotheque became the laboratory of an audiologist studying noise. His tests show that loud music more than likely causes permanent damage to the hearing of 16 percent of the people who go to discotheques frequently and stay for as long as two hours. The audiologist suggested that dancers might take a tip from musicians, who treasure their hearing. "They wear earplugs to cut the volume," he said. "They know too much of that 'good sound' can be dangerous."

The din of our cities is physically fatiguing. New York City is the worst example. Besides the clamor of taxicabs, buses, subways, trains, trucks, jets, air conditioners, and sirens, New Yorkers are subjected to the sound of 80,000 street repairs and 10,000 demolition and construction jobs annually. While there may be less noise in other cities, there is still enough to cause constant irritation. The dawn patrol of garbage trucks startles citizens in Denver, Miami, or Washington, D.C.

Before noise can be reduced, it has to be measured. A scientist rates a sound's energy in decibels, an acoustic yardstick adopted from the telephone industry and named after Alexander Graham Bell.

Rating noise, however, is no simple matter. There are many decibel scales, weighted according to the pitch of the sound being measured. The most common weighting system is the "A" decibel scale, written dbA. On this scale, rustling leaves register twenty dbA; conversation, forty;

The Lamp, *Summer 1970.*

heavy city traffic, ninety; a jet airliner 500 feet overhead, 105. Injury to the ear begins at sound levels above eighty dbA. However, a man does not feel pain until the decibel reading exceeds 120.

The location of a noise can be significant. An explosion in a dense forest is quickly absorbed by trees, leaves, and matted ground. But a firecracker in an elevator can be deafening. Thus, each noise must be evaluated in the place where it is heard. And each noise-cutting effort must be tailored to its environment. An elementary school demands more quiet than a bakery. Therefore, sound-absorbing carpeting would be a likely choice for classrooms, less so for a bakery.

The anti-noise effort has some victories to report. For example, the old-fashioned pile driver is being replaced by a new machine. Instead of beating piles into the ground, the new machine vibrates the shafts—sinking them as much as one foot per second—with two 500-horsepower diesel engines. It still makes noise but a lot less than the old way, and the ground shocks are all but gone.

The air compressor has been another noise pest. However, following the lead of Britain and Sweden, a major U.S. manufacturer recently announced a "socially acceptable" compressor. Now sold in considerable numbers, it is about six decibels—or 99 percent—quieter than a conventional unit the same size. It was used in the construction of the fifty-four-story building that will become Exxon's New York headquarters next year. The new compressor costs 25 percent more than the old noisy compressors, one of many indications that reducing noise can be expensive. Jackhammers also have been muffled with deadened steel bits that cut down the rat-a-tat impact noise.

As a major manufacturer, Exxon tries to make its operations as quiet as possible. At a new refinery in Benicia, California, the company went further, seeking to be less visible as well as quieter. Choosing the refinery's location was the first step. Exxon Company, U.S.A., Exxon's U.S. operating affiliate, tucked it away in the California

Photographed by David Attie

hills thirty-five miles northeast of San Francisco. Then it was painted to blend with the gold and green of the land. And native plantings were added.

To help quiet the new refinery, Exxon Research and Engineering Company, Exxon's technical affiliate, prescribed $700,000 in noise-control equipment. And efforts are still continuing to reduce unexpected noises that turned up when the refinery began operating.

New refineries abroad are also built to be quiet neighbors. Different methods are used to quiet furnaces, which are potentially noisy facilities. At Ingolstadt, West Germany, Exxon engineers designed a muffled passageway, instead of a natural, open draft, to feed air to the plant's furnace. Because the passage is muffled, the roar of combustion is greatly diminished. For new plants at Port Jerome, France, the engineers recommended "forced-draft burners" that deaden the noise blast from the furnace. But furnaces aren't the only facilities that require muffling. At both the Ingolstadt and Port Jerome refineries, blowers, compressors, and large electric motors were muted by insulation.

At Fawley, England, Exxon's refinery was built in a quiet, rural area, so control of neighborhood noise has always been an important activity, which in the last five years has cost about $1 million. The refinery's environmental engineer works closely with acoustic experts from Southampton University to measure and control noise that might disturb people living nearby. The standard Exxon specification drawn up to control in-plant noise has recently been accepted as a model by the oil industry in Britain.

At existing refineries in the United States and overseas, Exxon engineers are conducting studies and planning control devices. Many noise problems require custom-designed mufflers. Sometimes the structure of a furnace must be changed.

Exxon soundproofs its employees as well as the public. Measuring the noise a man is exposed to is the first step. To determine a refinery's noise profile, Exxon engineers use a noise analyzer that translates sound into an ink line of high and low sonic peaks. This is important in detecting brief, high-pitched noises which can be harmful. After identifying a noise, the engineers search for its origin and a way to eliminate it. When a noisy area is identified, employees in the area are fitted with earplugs and earmuffs, or work schedules are staggered to reduce their exposure until the noise level can be reduced.

In the nation, noise-cutting inventions are being tried. New York City has taken a step toward lessening the racket made by its 4,000 garbage trucks. Over the next two years the city is buying 1,100 "quiet" garbage trucks, which will cost taxpayers $100 more for each truck.

People who live around airports will be glad to learn that the new Boeing 747 superjet, now flying coast-to-coast and transatlantic routes with passenger loads of more than 350 people, is a step forward in aviation noise reduction. The plane's engines are insulated, making the jets considerably quieter than smaller airliners. As John Shaffer, head of the Federal Aviation Administration, says: "You'll like the sound of the 747. It's a very soft roar."

There is also reason to expect that the FAA may soon require the airlines to modify their conventional jets to halve the noise at takeoff and landing.

The supersonic jets—the SSTs—which will be flying before the end of this decade, have a built-in noise problem. Because they fly at speeds up to 1,800 miles per hour, they break the sound barrier, creating window-rattling sonic booms. If technology does not come up with an answer by flight time, the glamorous jets may be confined to transoceanic routes.

The country has begun to decide how much noise it will tolerate. Last May, Congress added a series of new noise-regulating provisions to the old Walsh-Healey Public Contracts Act of 1938. These provisions limit industrial noise levels in the 70,000 plants that have contracts with the federal government. Twenty-seven million people are employed by these firms. In New York City, a nine-month-old Bureau of Noise Abatement will set and enforce noise standards. California, Oregon, and Washington now have noise codes, and legislation regulating noise has been introduced in many more states. Connecticut highway patrolmen have been armed with sound meters and cameras to apprehend highway noise violators. The Federal Highway Safety Bureau is considering a proposal to equip cars with a loud horn for country driving and a quiet one for city use—a method long used in Europe.

Indeed, several European nations are well on the way to cities, homes, and highways fit for human ears. Since 1967, Britain has had a national standard for rating industrial noise affecting residential areas. The West Germans, who have various categories of noise limits, offer tax concessions and easy credit to manufacturers who muffle machines produced before noise laws appeared. A driver can find the maximum noise his vehicle is allowed to make stamped on his license. Zurich has an office of noise control manned by four inspectors. In the Netherlands, the government is making intensive efforts to develop quieter housing—eliminating such nuisances as paper-thin apartment walls. European building codes have had noise-control clauses for more than thirty years, especially for apartment buildings. The United States has no national building code, but state and local legislatures have made sporadic noise-control efforts. The subway, a pit of noise in American cities, has been tamed in Paris, Montreal, and Mexico City by such innovations as rubber wheels or "sound-dampening" coatings on the steel wheels.

The battle of the blare has begun. The fight will be a long one. New York expects to wait as long as five years to become "a perceptibly quieter city" and a decade before a definite decrease in noise is noticed. In most cities, it will take that long to reduce the noise we now endure and to plan noise out of our future machines, buildings, and vehicles. Unless noise is reduced, one medical authority grimly notes, we may all be stone-deaf by the year 2000. He suggests that there ought to be a better way to achieve a quieter world. ■

what's to be done with old tires?

As tires go bald and their carcasses grow old, they are often discarded indiscriminately—in fields, along highways, and in waterways. It's been estimated that there might be 2 billion discarded tires despoiling the United States landscape.

Tires wear out in the United States at the rate of 200 million a year. About 20 percent of these are re-treaded; another 7 percent are ground up and recycled for use in other rubber products. That leaves about 150 million worn out tires with seemingly no place to go. Tires are difficult to get rid of by conventional disposal methods. When incinerated, they give off unacceptable and illegal air pollutants. When buried in landfills they have a tendency to rise to the surface. And they don't disintegrate or dissolve.

Among those concerned, Firestone and Goodyear, the 2 largest tire makers in the United States, are enthusiastic and hopeful about some of the things being done to put old tires to good use. Firestone, for example, has what it calls a destructive distillation plant in the pilot stage. According to J. R. Laman, manager of environmental engineering for Firestone, this unit "could be the ideal form of total pollution control." He emphasized the word "could." While destructive distillation is technically feasible, its cost is extremely high, and the products from it need further refinement before they can be utilized.

The process is said to show promise of becoming a practical method for returning to the production cycle the raw materials that went into tires. Since many of these materials are made from chemicals derived from petroleum and gas, such as butadiene, isoprene, butylene and styrene, the process holds the potential of recycling valuable and diminishing natural resources.

A Goodyear facility has taken another approach to giving new life to tires; it will use them as fuel in a new $550,000-furnace now in the final stages of installation. Howard Tolley, Goodyear's community relations manager, said the tire-fired furnace "is the beginning in this country of one of the most promising methods of disposing of old tires and conserving energy."

Made principally of petroleum-derived materials, tires hold substantial amounts of energy locked in their carcasses. Pound for pound, they have 50 percent more Btu value than coal. The furnace is designed to consume 3,000 casings daily, more than one million a year. It will produce enough energy to heat 250 homes for a year but will be used by Goodyear to produce steam for new tire production. Smokeless and odorless, the furnace meets rigid air pollution standards.

Old tires also are finding many uses simply as cast-off tires. Hundreds of thousands of them are used to create artificial reefs as a haven for game fish and other aquatic life. After a few months on the ocean floor, tires become coated with such organisms as algae, barnacles, mussels and coral. Attracted by these organisms, fish begin to inhabit the area. Scientists at one location counted 88 different species of fish before the tire haven was 2 years old.

Goodyear has been a leading advocate of artificial reefs and is actively involved in major pilot projects in Florida, Australia, Greece, Jamaica, Japan and New Zealand. The U.S. Interior Department estimates that well over one billion tires can be disposed of in artificial reefs on the U.S. East Coast alone.

Another use that shows promise is the reuse of worn tires as highway crash barriers at such danger areas as bridge piers and abutments. In tests conducted by the Federal Highway Administration, an auto was driven into an unprotected pole at 56 miles per hour, demolishing the vehicle. A car driven against a similar pole, protected by the Goodyear-developed tire crash barrier, received $175 worth of damage. It is estimated that there are half a million highway points in the United States that should have crash barriers.

The highway use of old tires is not limited to safety barriers. In a new process, they are being reworked to make road building materials. By stripping out and devulcanizing the rubber, processors achieve a compound that mixes with regular paving asphalt. Though slightly more expensive, the mixture makes a more durable surface, is easier to apply and spreads more quickly.

In hot weather, it reduces seepage of the asphalt at the edges and to the surface. This seepage is a skidding hazard, particularly when the road is wet. New York State used the material to seal joints and cracks in the Dewey Thruway, and maintenance men found that the joints have to be resealed half as often. Arizona has rubberized asphalt on streets and airport aprons. Wisconsin is also testing the mix, as is the U.S. Bureau of Public Roads.

Playground, patios and swimming pools also still see a good share of old tires in new forms. Imaginative playground directors are designing mountains, jungles and giant swings using little more than old tires. The casings are chopped up and bonded with a rubber-based binder. Paint is added and the result is a colorful, creative surface.

Some companies are considering storing old tires in abandoned quarries or shelters, filling them with water to reduce the hazard of fire and keeping them for the day they might be needed as a source of fuel or raw material. ■

Exxon Marketing Exchange, *Number 3, 1974.*

energy and the environment: striking a balance

A formidable problem confronts not only the oil industry today but society as a whole. Some have referred to it simply as the "energy dilemma." I prefer to think of it as a delicately balanced equation—the energy-environment equation. One part of the equation is the problem of supplying the vast amounts of energy required to provide rising standards of living to rapidly expanding populations all over the world. The other part of the equation is the necessity of preserving the natural environment upon which the quality—and survival—of life on this planet must ultimately depend.

I, for one, am confident that practical and effective answers can be found to the equation—that the conflict between the need for more energy and the desire to preserve the quality of life will be resolved. But our success will depend upon the amount of patience, determination, intelligence, and hard work that we are willing to bring to the task. Ill-considered and emotional responses aren't going to help at all. To be brought into proper balance, both sides of the energy-environment equation must be carefully weighed and properly understood.

The first part of the equation has to do with the growing demand for energy all over the world. Let's take the United States as an example.

For several years, U. S. energy consumption has been rising about 5 per cent annually—faster than our gross national product and more than four times as fast as the U. S. population. Between now and 1985 our demand for all forms of energy is expected to nearly double.

Such a fantastic growth in energy demand reflects the fact that Americans are calling for goods and services in increasing variety and quantity. Our country's automobile population has grown twice as fast as its human population over the past ten years. Eighty million cars are on our highways. By 1985 this figure is expected to increase to more than 120 million. Consumption of electricity is also increasing sharply and by the end of this decade is expected to double. The end uses to which these volumes of power are being put are becoming increasingly sophisticated: for example, fully 16 per cent of the total increase in electric power consumption in the United States last year was for the operation of air conditioners!

Other countries are on the move as well. In the past five years alone the world's population has increased by 300 million to almost 4 billion. By the end of the century, world population is expected to reach more than 6 billion. Per capita income and consumption are also rising sharply, and worldwide energy use is expected to treble or even quadruple by the end of the century.

You might well ask where all this power is going to come from—or if all the world's demands for energy can possibly be met. Let's look at this question more closely, again paying particular attention to the United States.

Looking forward, here's what our company sees for the basic energy sources now available or likely to become available in the years immediately ahead:

> Hydroelectric energy growth is sharply limited by the availability of acceptable dam sites. Although additional capacity will continue to be developed, hydroelectric's share of total U.S. energy requirements is expected to slip from 4 per cent today to only 2 per cent in 1985.

> Nuclear energy today supplies less than 1 per cent of total U.S. demand. By 1985 we estimate that its share will increase to about 11 per cent. We share the administration's view that the fast-breeder reactor may yet prove to be "the best hope...for meeting the nation's growing demand for economical, clean energy," but our optimism is tempered with caution. The first demonstration fast-breeder plant is not expected to be completed until 1980, and technical and environmental difficulties must be overcome if this target date is to be met. These same problems, together with construction delays, have already caused the supply of power from nuclear plants to fall well behind the levels forecast. The shortfall between the Atomic Energy Commission's 1967 forecast of 1970 capacity and that actually achieved was equivalent to the power generated by 14 million tons of coal per year, or 140,000 barrels per day of heavy fuel oil —and this is precisely how the slack has had to be taken up: by fossil fuels.

Coal has contributed an important share of the nation's energy in the past and will continue to do so in the future. After slow growth in the next four or five years, we expect to see consumption double between now and 1985, raising coal's share of the energy market from its current level of 18 per cent to approximately 20 per cent. Demand for coal will develop in response to time lags in nuclear power plant construction, limited natural gas supply, and the national security consideration of overdependency on imported oil. This projected growth is, however, contingent on the development of technology that will permit the use of coal within the framework of the prevailing air conservation regulations.

Synthetic fuels—including oil and gas from coal, and oil from shale—will, we predict, be available for commercial use by the end of this decade; but by 1985 it is doubtful that they will supply more than 2 per cent of this nation's energy requirements. And even this development will depend upon the perfection of economic processes and upon national policies encouraging the development and utilization of synthetic fuels.

Which brings us to natural gas and petroleum.

Natural gas is the United States' second largest source of energy. Unfortunately, prices have been controlled by the U.S. government at an artificially low level. This has accelerated demand but has not provided adequate incentives to explore intensively enough to find the additional supplies required. As a result, reserves of natural gas are dwindling, and not even substantial new volumes from Alaska and Canada are expected to reverse this trend. Thus, natural gas's share of total U.S. energy supply is expected to decline from about 33 per cent today to about 21 per cent in 1985.

Statement by Exxon's Chairman, The Lamp, *Spring 1972.*

"The overall objective must be to provide an adequate supply of energy at a reasonable balance between cost, dependability, and protection of the environment"

Petroleum consumption, we predict, will just about double by 1985—from 15 million to 28 million barrels a day—although its share of the energy supply will remain at about the present level of 45 per cent.

Because domestic oil production is expected to decline in absolute terms, it will become increasingly necessary for the United States to balance its energy supply with imported petroleum. By 1985 our forecast indicates that imports will supply more than 60 per cent of U.S. demand. This prospect should, I think, provide a strong incentive for the United States to step up leasing for exploration along the continental shelf and to move more rapidly in establishing environmental regulations that will provide appropriate safeguards to permit sound development in frontier areas such as Alaska. Certainly we need to add to our reserves, and the sooner we get on with the job the better. Dependence on imported oil can be lessened only by a significant change in the policies of the federal government toward the domestic oil and gas industries and by an acceleration in the development of alternate sources of energy.

To meet the long-range energy needs of the United States, we can no longer afford to develop our country's individual energy resources in isolation, one from another, any more than we can attempt to resolve our energy problems in isolation from the rest of the world. It is essential that total energy supply and demand be recognized as a single problem and one that must, inevitably, be faced by the United States together with other countries.

To protect the energy consumer in the United States—which is all of us—our energy policies must encourage the maintenance of healthy energy-producing industries. The policies must provide maximum encouragement for the development of all our domestic energy sources. The policies must also take into consideration the needs and aspirations of other nations and provide contingency plans for meeting possible disruptions in foreign supplies. The overall objective must be to provide an adequate supply of energy for present and long-term needs at a reasonable balance between cost, dependability, and protection of the environment.

In the United States today, public concern for the environment probably commands more attention than concern for national energy supplies. Limited natural gas supplies and increasingly frequent electrical brownouts—there were fifty-four last year alone—remind us that new sources of energy must be found. But the threats to which our natural environment is being exposed have to many people been more noticeable, more immediate, and more alarming.

Some would have us bring the energy-environment equation into proper balance by putting tight reins on economic growth. But is this realistic, considering current population projections and the aspirations of people everywhere to improve their lot? I hardly think so. The question is not if energy production should continue to increase but how the energy supplies can be provided without irreparable harm to the environment.

I am convinced that this challenge can be met—that acceptable levels of air and water purity can be achieved at a price we can all afford—in both an economic and a social sense. But if this and the broader goals of environmental conservation are to be realized, all segments of society must lend a hand:

> National governments must enact laws and establish codes that will best serve the public both from an environmental and economic standpoint.

> Local governments must install the equipment and controls necessary to rid our environment of untreated sewage, smoke, and refuse from incineration.

> The individual citizen must be willing not only to accept his fair share of the economic burden of the cleanup campaign but to alter attitudes and behavior patterns that have contributed to environmental deterioration.

> And business and industry must contribute to these community-wide undertakings in every way possible, not only by raising their own standards but also by accelerating their efforts through research to discover new and better ways of protecting the environment.

Business must accept this challenge and set an example others might follow.

Much has already been achieved and greater efforts are under way. From 1966 through 1970, for example, U.S. oil companies alone have spent more than $2 billion on environmental conservation. Today such expenditures are running at about $1.5 million each day.

Other industries are working hard toward conservation objectives. The Environmental Protection Agency recently estimated that the auto industry is spending some $330 million annually on emissions control research. Many other industries are investing substantial sums of money to reduce the discharge of pollutants.

Today the need is not—as some would have it—to call a halt to progress and to negate the tremendous achievements and social advances that have been brought by the industrial revolution. Our efforts as individuals, as members of the business community, or as representatives of government must be directed toward finding ways of reconciling our economic needs with the preservation of our environment. This can be done through a more rational utilization of natural resources and a more thoughtful and intelligent management of our environment.

We can no longer afford to ignore our environment. Nor should we seek to "conquer" it. The proper course, I believe, must be to seek a more harmonious collaboration with nature's forces: a balancing of the energy-environment equation that will both supply the energy needed to meet the demands of the world's population and preserve the environment in which we all live.

February 1, 1972

J. K. Jamieson

J. K. JAMIESON, *Chairman*

publications and films available

Publications

The following publications can be obtained from the Public Affairs Department, Exxon Corporation, 1251 Avenue of the Americas, New York, N.Y. 10020.

Exxon Background Series:
Environmental Conservation—A Progress Report.
The Offshore Search for Oil and Gas.
Reducing Tanker Accidents.
Very Large Crude Carriers (VLCC's).

Breathing Space. The subject is air pollution. The booklet describes the main sources of atmospheric pollution and details the measures taken by the oil industry in general and Exxon, in particular, to limit the pollutants emitted when petroleum products are used.

Passage to Cleaner Seas. This is a report on how the international oil industry, including Exxon, endeavors to reduce sea pollution. It covers tanker operations, loading and off-loading at terminals, offshore exploration and production, oil spill cleanup and containment technology.

Striking a Balance. The balance is between the need to develop sources of energy and the preservation of a healthful, unspoiled natural environment. The booklet describes how this has been achieved in many areas through the careful design and operation of oil and natural gas facilities.

Films

The following films are available on a free-loan basis. They may be ordered by writing Modern Talking Picture Service, Inc., 2323 New Hyde Park Road, New Hyde Park, New York 11040. Include number and title of the film.

Sea Venture, #4876. This award-winning film tells the story of a new kind of seafarer—those who work for weeks at a time on offshore rigs drilling for oil and natural gas. Shown are the design of different rigs, the equipment used to prevent blowouts and pollution, how oil moves from sea to shore. A teacher's guide is available. 28 minutes, 16mm, sound, color.

Offshore, #4880. The search for new supplies of oil and gas is increasingly moving offshore and into deeper waters. The film depicts this search from the initial exploration stage to development drilling and actual production. A teacher's guide is available. 18 minutes, 16mm, sound, color.

Evidence of Progress, #4882. There is no quick and easy way to improve the quality of life on our planet EARTH. A balanced environment will be the result of many small and patient efforts. It will take time and inspiration and money and dedication. This award-winning film offers encouragement to keep working on environmental problems by citing examples of places around the world where progress in reversing past trends of environmental degradation has been achieved.

The Three E's, #4900. Environment, energy and economics. These three E's are interrelated, and neglect of one must result in disastrous consequences to the other two. The film calls for "a more compassionate technology,"—an approach to economic growth that permits us to make profitable use of our natural resources while preserving and restoring the environment from which these resources are drawn. A teacher's guide is availble. 28 minutes, 16mm, sound, color.

World Beneath the Sea, #4901. The film depicts the day-and-night vigil maintained by oil companies to protect the environment as they drill for oil and gas beneath the sea. Discussed are technological developments – camouflaging drilling platforms as high-rise apartment buildings, computerized controls, underwater television cameras for inspection, advanced drilling systems that operate by remote control on the ocean floor. 28 minutes, 16mm, sound, color.

Filmstrips

Two series of 35mm, color filmstrips produced by the Cousteau Society are available for rent or purchase. Included in each set are the filmstrips, cassette tapes and a teacher's guide. Contact Modern Talking Picture Service, Inc., 2323 New Hyde Park Road, New Hyde Park, New York 11040.

Undersea Explorations. These four filmstrips explore all facets of undersea investigation. They include such subjects as why women are better "water creatures" than men; how a bathyscape works; why oceanographers go aloft in balloons to study whales; how oceanauts eat, sleep and work at depths to which no diver can safely venture.

The Life of Fishes. Six filmstrips which portray sea animals—their habitats, complex societies, success and failure in surviving ecological hardships.

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